THE REPUBLIC OF KOREA

MASTER PLAN AND FEASIBILITY STUDY
ON
SEOUL MUNICIPAL SOLID WASTE MANAGEMENT SYSTEM
IN
THE REPUBLIC OF KOREA

FINAL REPORT

APPENDIX

OCTOBER, 1985

JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO, JAPAN

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APPENDIX I GENERAL BACKGROUND

1. STUDY BACKGROUND

In response to the request of the Government of the Republic of Korea, the Government of Japan has decided to conduct a Master Plan and Feasibility Study on Seoul Municipal Solid Waste Management System in the Republic of Korea. The events leading to this request which form the background of this Study are presented below.

1. Urbanization of Seoul City is now in a stage of drastic change as witnessed by construction of high-rise apartments, development of large-scale residential areas, subway construction and other city planning projects. This has resulted mainly from population concentration into the metropolitan area. As a consequence of this phenomenon and changes in the socio-economic structure, realization of an appropriate planning for solid waste managemment has become an urgent necessity for Seoul City.

2. The 1988 Olympic Games are scheduled to be held in Seoul City. Aiming towards the Games, improvement of the urban environment has become a major goal for Seoul City.

3. As part of this endeavor, a comprehensive planning on solid waste management involving the flow from waste generation to final disposal is required for Seoul City. In this context, the following subjects must be taken into consideration.

   a. Characteristics of the solid waste in Seoul City

   b. Sanitary and rational methods of solid waste collection and transportation

   c. Practical use of private companies as proxies for public bodies

   d. Alternative plans for intermediate processing and final disposal, in which environmental sanitation and finite space of disposal sites are considered

   e. Various approaches for effective recovery of resources from solid waste

   f. Consideration of related projects in Korea.

2. INTERPRETATIONS OF SOLID WASTE MANAGEMENT

2-1 Historical Sketch

Years ago, almost everything was either reused or traded with others who could reuse them. Furthermore, the non-reusable residues were simply buried in the generators' backyard. This act was carried out unconsciously by the generators, because nature has accepted the responsibility for receiving the unwanted things and assimilating them back to natural things.

However, as the population increased and the humans generated more and more of the unusable portion, nature became hands-full and could no longer tolerate these things. This caused the unwanted things to accumulate in the living environment of the generators. The people came to grips with the reality of undersired conditions and this situation was then admitted as a problem.

At first, the most likely solution was to dump these things together in one location isolated from the residential area. Then, this started to create problems to the natural environment such as contamination to water resources, dangerous gas emissions with resultant explosions and other nuisances. As this situation progressed further, administrators, engineers and scientists came to realize that something had to be done. As a consequence, new technologies have been and are still continuing to be researched and developed to safely and sanitarily control this menace. However, demonstrations of these technologies have been limited to only a few.

2-2 Expressions

The unwanted things or materials no longer of any use became to be known by many names. Starting from general terms such as refuse and garbage to specific ones such as junk and rags, the list goes on. In the Korean language, the words "suregi" and "pekimul" are common. A sample listing of terminology with Korean and Japanese counterparts are indicated in Table I - 1. In this report, the words "refuse" and "solid waste" are used interchangeably to mean the same substance.

Table I-1 Terminology Correspondence

English	Korean	Hangul	Japanese
Waste	Omul, Pekimul	오물, 폐기물	Obutsu, Haikibutsu
Solid Waste	Kohyon Pekimul	고형폐기물	Kokei Haikibutsu
Refuse	Suregi	쓰레기	Gomi
Garbage	Umsikchikeogi	음식찌꺼기	Chukai
Rubbish	Chaptahan Suregi	잡다한 쓰레기	Zakkai
Trash	Busurogi	부스러기	Kuzu
Litter	Busurogi	부스러기	Kuzu
Dust	Monji	먼지	Chiri
Debris	Jabdongsani	잡동사니	Gareki
Scraps	Jabdongsani	잡동사니	Garakuta
Junk	Jabdongsani	잡동사니	Garakuta
Dreg	Chikeogi	찌꺼기	Kasu
Rags	Nongma	넝마	Boro
Dross	Swebusureogi	쇠 부스러기	Kanakuzu
Slag	Swenok	쇠 녹	Kanakuso

Well, what is solid waste management? Before going into the description of solid waste management, other expresssions will neeed to be clarified.

Cleaning refers to the act of removing whatever is foul, filthy, offensive to extraneous, and cleansing is the act of one that carries out the cleaning. Other synonymous words are dusting, sweeping, scrubbing and purging. Therefore, "cleansing" will be used for the organization responsible for solid waste management in this report.

In this Study, the act of hauling waste from a transfer station to the final disposal site is referred to as either transportation or transport. These two words have the exact same meaning and therefore are used without discrimination in this report.

The stage of management before final disposal is called intermediate processing in this Study. Processing is the act of carrrying out a certain operation to change the physical or chemical properties of a substance. Treatment has, in a sense, the same meaning. However, in the field of environmental science and sanitary engineering, treatment is used to mean a purifying activity such as that for removing contaminants from raw water sources or sewage. On the other hand, processing does not necessarily purify a substance, but can only change the visual appearance. In this context, the word processing is believed to be more appropriate for the case where solid waste is concerned.

2-3 Waste Stream

A general solid waste managment system involves the flow of activities from on-site storage through collection/transportation and intermediate processing all the way to final disposal. This stream is illustrated in Fig. I-1.

On-site storage is carried out by waste generators at the source of generation. Various storage methods are available, but according to the storage method, collection efficiencies differ. Furthermore, separate storage of various components of waste can increase the efficiency of intermediate processing at a later stage of the flow.

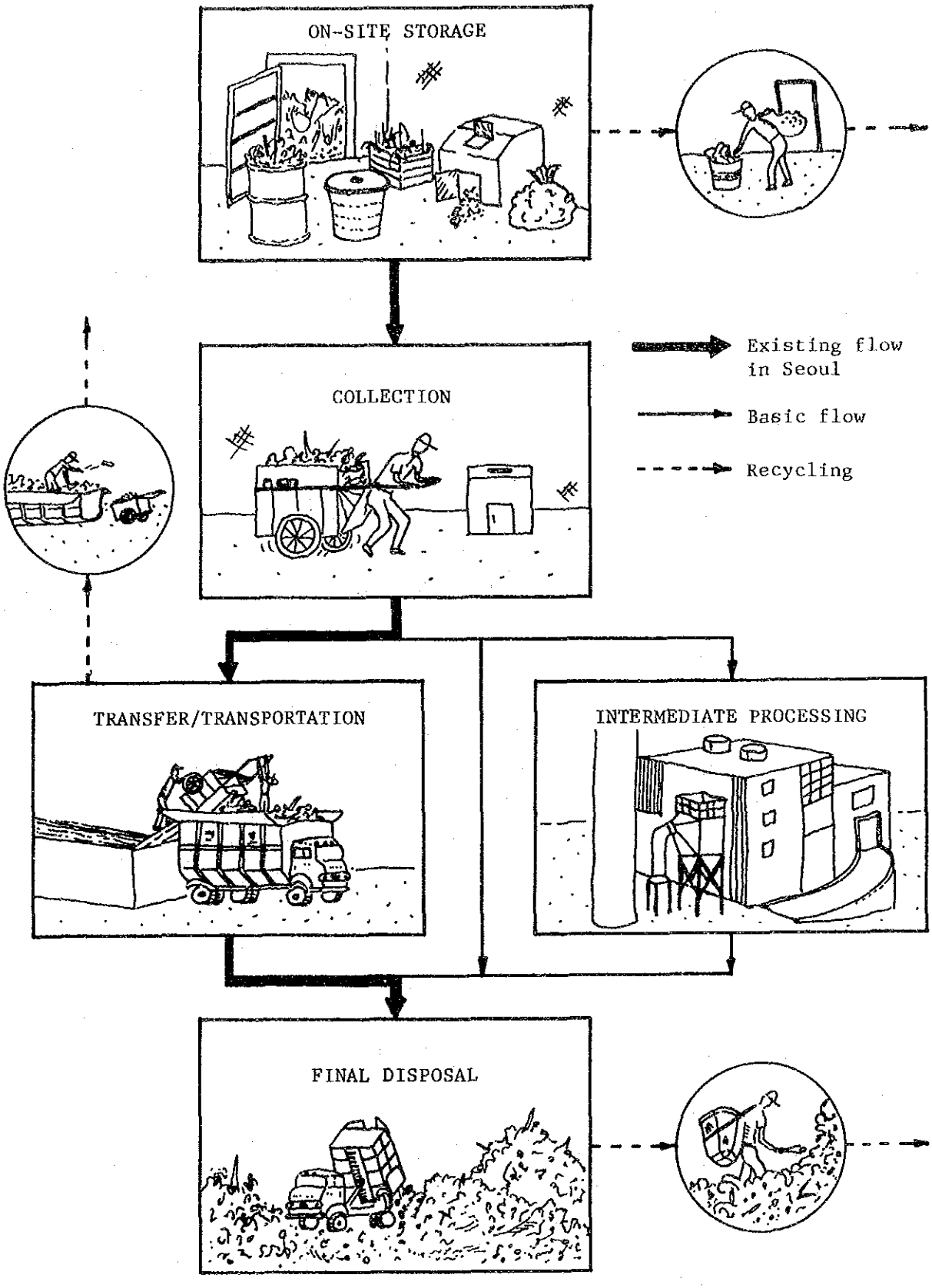


Fig. I-1 Flow Diagram of Solid Waste Management

Collection can be performed by manual or mechanical means. In Seoul City, a manual method of door-to-door service is taken. The type of housing, width of roads and other factors affect the collection method to be selected.

The collected refuse either goes to a transfer station or a processing plant, or directly to the disposal site. Transfer is required when hauling distances are long. If a transfer station is used, the accumulated waste needs to be transported from the station to a processing plant or disposal site.

Intermediate processing involves various unit processes systemized to cause volume reduction, stabilization and harmlessness for optimizing the next stage of disposal, and to recover resources needlessly wasted to the environment. In Seoul, this step of the management is not fully understood, because operation of a full scale processing plant has not been carried out in Korea as yet.

Resource recovery and recycling are acts of extracting materials or energy out of the waste stream for recirculation into the consumer system. Since Korea, as in Japan, is a resource-poor country, this concept is very significant to conserve natural resources. Resource recovery can be planned along with the intermediate processing system.

The most common method of final disposal is landfilling, as is the case in Seoul City. Careful planning of disposal is required so as not to disrupt the environment. Since final disposal is inevitable in any solid waste management, planning of the sites is a vital subject for an optimum solid waste management system.

APPENDIX II

STUDY AREA SITUATION

APPENDIX II STUDY AREA SITUATION

1. NATURAL CONDITIONS

1-1 Geography

Seoul City lies in a wide valley along the Han River spreading 37 km long in the east-west direction and 30 km long in the north-south direction. The city is characterized by the crawling river flowing towards the west and the surronding hills which restrict the expansion of the city.

The slope of hills are generally steep over an elevation of 100 meters above sea level. Thus the developed areas are found below this level.

The large extent of alluvial deposits are found in eastern Seoul. It consists of clay, silts, sands, and gravels. In western Seoul, clays, silts, and rich organic muds dominate the alluvium.[1/]

1-2 Meteorology

The annual average temperature ranged between 10°C to 13°C since 1977 through 1982 (Table II - 1). The lowest temperature in 1982 was -14.1°C recorded in January, and the highest was 35.5°C in August. The annual precipitation was 1,269 mm in 1979, and 949 mm in 1982. In 1982, the maximum monthly rainfall was 256 mm in August, and the minimum was 3 mm in February.

The average wind speed ranged between 2.3 m/sec and 2.6 m/sec since 1977 through 1982. The monthly average in 1982 fell between 2.0 and 2.9 m/sec. The maximum speed was 13.0 m/sec recorded in November. The predominant wind direction is west in summer and northeast in winter.

1/ Source: Han River Basin Environmental Master Plan

Table II - 1 Climatological Data of Seoul

	Temperature (°C)			Precipitation (mm)	Evaporation (mm)	Wind (m/sec)	
	Average	Maximum	Minimum			Average	Maximum
1977	12.3	35.0	-16.8	1147.5	1202.2	2.3	14.7
1978	12.4	36.1	-16.0	1160.9	1130.1	2.3	15.2
1979	12.5	32.6	-13.0	1269.4	1093.5	2.5	17.3
1980	10.8	31.7	-16.2	1242.4	1045.0	2.6	17.7
1981	11.2	35.2	-16.5	1216.2	1017.5	2.6	15.0
1982	12.5	35.5	-14.1	949.3	1075.0	2.5	13.0
Jan	-3.6	6.8	-14.1	26.0	38.1	2.7	9.2
Feb	0.6	12.3	-11.8	2.9	51.7	2.5	8.3
Mar	5.9	17.0	-5.3	46.0	92.7	2.9	9.7
Apr	12.3	27.5	3.1	8.1	4.6	2.9	10.3
May	17.9	28.9	8.0	134.6	127.8	2.9	11.7
Jun	21.9	30.6	11.7	15.7	153.1	2.4	8.0
Jul	25.1	33.7	18.3	195.5	155.6	2.4	8.3
Aug	25.4	35.5	18.3	255.8	103.4	2.4	12.0
Sep	20.8	30.9	9.9	4.8	145.3	2.0	11.0
Oct	15.8	28.2	-1.1	46.5	107.2	2.1	11.0
Nov	7.9	21.4	-7.1	164.8	56.7	2.3	13.0
Dec	-0.1	10.6	-9.8	48.6	38.8	2.5	10.3

Source : The Central Meteorological Office

2. LAND USE

2-1 Existing Land Use

In 1982, Seoul covered an administrative area of 62,706 ha, of which about 15 percent was agricultural land, about 28% was forest land and about 29% was residential land (see Table II - 2 and Fig. II - 1). These percentages have been changing yearly. Especially the decrease of agricultural land was rapid from 1976 to 1982. The converted area to other land uses came up to about 4,600 hectares. On the other hand, residential land gained about 3,400 hectares during the same period, including the growth of the areas for schools and roads. On the contrary, the area for factories decreased in 1982 for the first time in recent history. This decrease might have reflected the effect of the government's policy to reduce the factories in Seoul City. As the population grows, the land use for residential area, school, road and park-playground-public pleasure is expected to increase.

Table II - 3 displays the existing land use by zone and Gu in 1982. According to the figures in this table, the main agricultural lands over 1,000 hectares are distributed in Dobong-Gu, Ganseo-Gu, Gangnam-Gu and Gangdong-Gu. These agricultural areas are precious green spaces for overpopulated urban areas in Seoul City. In these areas, some housing development projects are under planning. At Mokdong in Ganseo-Gu, Kaepo in Gangnam-Gu and Kodok in Gangdong-Gu, new town development projects have just started (Fig. II - 2). The agricultural areas are decreasing rapidly in these areas.

The main factories are located in six wards (Gu's). Guro-Gu has the largest factory area of about 230 hectares with three industrial estates. Like the case of agricultural land, the factory area is expected to decrease in the future due to the government's policy to remove them outside of Seoul City.

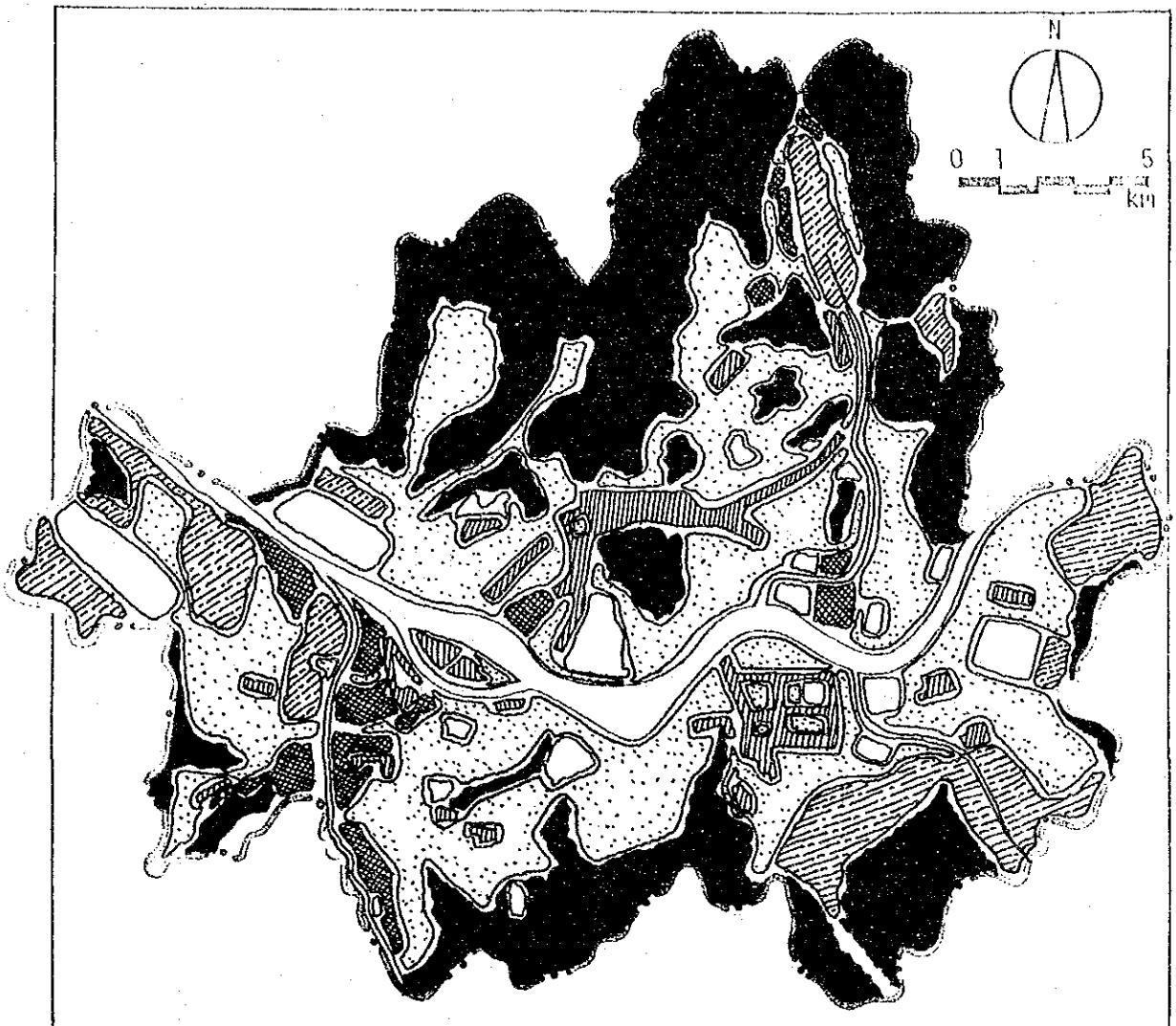
The land suitable for development in Seoul City is shown in Table II - 4 The ratios of developed area to the possible land for development is about 84 percent, and the undeveloped area is 5,863 hectares or about 16 percent.

Table II - 2 Existing Land Use in Seoul City

(Unit: ha)

Land Use / Year	Total	Ordinary field • Paddy field • Orchard	Forest land	Residential land	Factory	School	Road	Rail site	Park • Play ground • Public Pleasure	Others
1976	62,706	13,688 (21.8)	19,868 (31.7)	14,713 (23.5)	2 (-)	27 (-)	2,819 (4.5)	448 (0.7)	61 (0.1)	11,080 (17.7)
1977	62,706	13,229 (21.1)	19,756 (31.5)	15,041 (24.0)	7 (-)	110 (0.2)	2,743 (4.4)	454 (0.7)	96 (0.2)	11,270 (18.0)
1978	62,706	12,567 (20.0)	19,485 (31.1)	15,113 (24.1)	233 (0.4)	774 (1.2)	3,139 (5.0)	472 (0.8)	146 (0.2)	10,777 (17.2)
1979	62,706	12,274 (19.6)	19,638 (31.3)	15,536 (24.8)	290 (0.5)	815 (1.3)	3,455 (5.5)	483 (0.8)	130 (0.2)	10,085 (16.1)
1980	62,706	11,839 (18.8)	19,276 (30.7)	15,626 (24.9)	351 (0.6)	893 (1.4)	3,808 (6.1)	476 (0.8)	149 (0.2)	10,288 (16.4)
1981	62,706	10,770 (17.2)	18,778 (29.9)	16,329 (26.0)	453 (0.7)	1,003 (1.6)	4,212 (6.7)	483 (0.8)	197 (0.3)	10,481 (16.7)
1982	62,706	9,090 (14.5)	17,831 (28.4)	18,117 (28.9)	445 (0.7)	1,117 (1.8)	4,949 (7.9)	478 (0.8)	259 (0.4)	10,420 (16.6)

Source: Seoul Statistical Year Book
Note : The figures in parentheses indicate percentage of the total



L E G E N D

- Mountainous area
- Agricultural area
- Residential area
- Commercial area
- Industrial area
- Institutional area

Fig. II-1 Existing Land Use

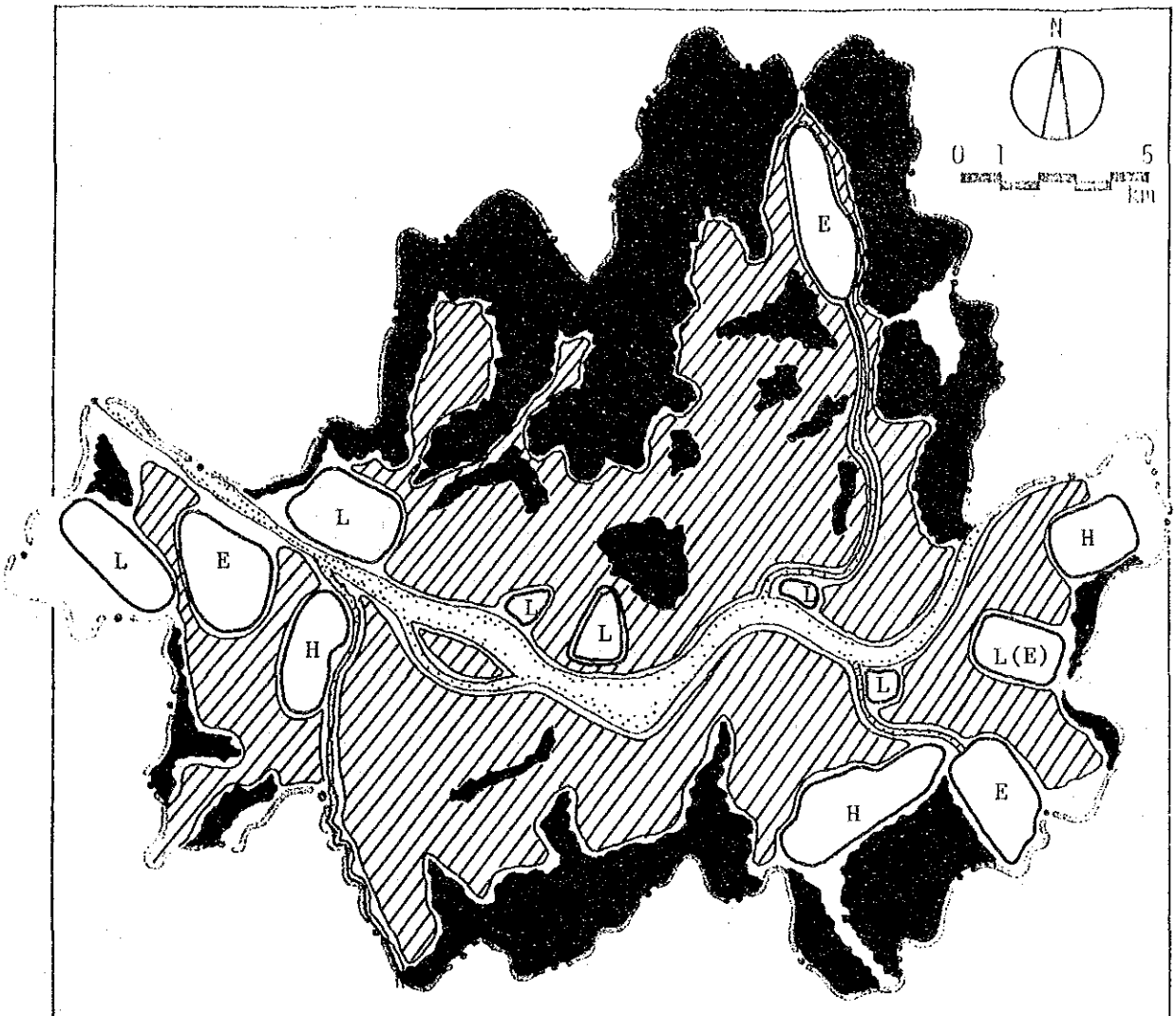
MASTER PLAN AND FEASIBILITY STUDY ON SEOUL MUNICIPAL SOLID WASTE MANAGEMENT SYSTEM

Table II - 3 Existing Land Use by Gu

(Unit: ha)

Land Type / Gu	Total	Ordinary field · Paddy field · Orchard	Residential land	Factory	School	Road	Rail site	Park · Play ground · Public Pleasure	Forest land · Others
Jongro	2,410	119	858	-	57	191	-	14	1,171
Jung	1,007	1	594	-	11	173	12	32	184
Zone I Total	3,417	120	1,452	-	68	364	12	46	1,355
Seongdong	4,082	277	1,367	61	130	393	16	81	1,757
Dongdaemun	3,132	482	1,339	-	72	367	43	4	825
Seongbug	2,483	47	1,016	-	99	205	6	3	1,107
Dobong	8,192	1,019	1,488	31	127	400	44	8	5,075
Zone II Total	17,889	1,825	5,210	92	428	1,365	109	96	8,764
Yongsan	2,138	15	1,017	-	25	190	141	1	749
Eunpyeong	3,275	185	900	-	30	235	20	3	1,902
Seodaemun	1,789	25	757	-	191	174	22	3	617
Mapo	2,381	414	804	-	53	212	51	4	843
Zone III Total	9,583	639	3,478	-	299	811	234	11	4,111
Ganseo	6,024	1,908	1,348	29	27	449	-	12	2,251
Guro	3,937	390	1,179	231	25	272	88	4	1,748
Yeongdeungpo	2,758	107	966	94	25	287	24	6	1,249
Dongjag	1,676	28	789	-	53	160	12	8	626
Gwanak	2,757	44	726	-	41	233	-	11	1,702
Zone IV Total	17,152	2,477	5,008	354	171	1,401	124	41	7,576
Gangnam	8,658	2,379	1,602	-	89	536	-	20	4,032
Gangdong	6,007	1,649	1,366	-	62	473	-	45	2,412
Zone V Total	14,665	4,028	2,968	-	151	1,009	-	65	6,444

Source: Seoul Statistical Year Book (1983)



L E G E N D

H	Housing development project area
E	Existing large open space
L	Large scale institutional facility area
▨	Urbanized area

Fig. II - 2 Location of Housing Development Project Areas and Existing Large Open Spaces

Table II - 4 Land for Development

(Unit: ha)

Classification / Gu	Administrative Area	Land for Development			Land Impossible for Development
		Total	Developed Area	Undevelopment Area	
Jongro	2,410	1,260	1,227 (97.4)	33 (2.6)	1,150
Jung	1,007	835	833 (99.8)	2 (0.2)	172
Zone I Total	3,417	2,095	2060 (98.3)	35 (1.7)	1,322
Seongdong	4,082	3,046	2,776 (91.1)	270 (8.9)	1,036
Dongdaemum	3,132	2,288	2,123 (92.8)	165 (7.2)	844
Seongbug	2,483	1,444	1,355 (93.8)	89 (6.2)	1,039
Dobong	8,192	3,880	2,643 (68.1)	1,237 (31.9)	4,312
Zone II Total	17,889	10,658	8,897 (83.5)	1,761 (16.5)	7,231
Yongsan	2,138	1,535	1,522 (99.2)	13 (0.8)	603
Eunpyeong	3,275	1,350	1,296 (96.0)	54 (4.0)	1,925
Seodaemun	1,789	1,392	1,346 (96.7)	46 (3.3)	397
Mapo	2,381	1,761	1,256 (71.3)	505 (28.7)	620
Zone III Total	9,583	6,038	5,420 (89.8)	618 (10.2)	3,545
Ganseo	6,024	3,560	2,588 (72.7)	972 (27.3)	2,464
Guro	3,937	2,827	2,654 (93.9)	173 (6.1)	1,110
Yeongdeungpo	2,758	1,920	1,838 (95.7)	82 (4.3)	838
Dongjag	1,676	1,037	1,008 (97.2)	29 (2.8)	639
Gwanak	2,757	1,433	1,392 (97.1)	41 (2.9)	1,324
Zone IV Total	17,152	10,777	9,480 (88.0)	1,297 (12.0)	6,375
Gangnam	8,658	4,428	3,233 (73.0)	1,195 (27.0)	4,230
Gangdong	6,007	3,459	2,502 (72.3)	957 (27.7)	2,548
Zone V Total	14,665	7,887	5,735 (72.7)	2,152 (27.3)	6,778
Total	62,706	37,455	31,592 (84.3)	5,863 (15.7)	25,251

Source: Urban Planning Division of Seoul Metropolitan Government
Note : The Figures in Parentheses indicate percentage of the total.

The population density in the developed area is very high at about 300 persons per hectare. Therefore, the developed areas can be considered as almost saturated.

Regarding the rate of developed areas to the possible land for development by Gu, in 12 wards (Gu) it exceeded 90 percent. Especially Jongro-Gu (97.4%), Jung-Gu (99.8%), Yongsan-Gu (99.2%), Dongjag-Gu (97.2%) and Gwanak-Gu (97.1%) show very high rates. On the contrary, Dobong-Gu, Mapo-Gu, Gangseo-Gu, Gangnam-Gu and Gangdong-Gu show high rates of undeveloped areas when compared with others. As these undeveloped areas are very precious land resources for Seoul City, thoughtful development plan and/or conservation plan should be prepared.

2-2 Housing

The trend of the dwelling units construction in Seoul City is shown in Table II - 5. As is evident from this table, construction of apartment houses exceeded approximately 50 percent of the total dwelling units. Annual construction of the townhouses, which are two to three story collective houses, showed also relatively high rates at about 20-30 percent of the total dwelling units. As to the detached houses, the construction share was about 20 percent of the total dwelling units. As this tendency of the dwelling units construction continues, the share of house types in the total dwelling units may change significantly. The apartment houses and town houses are growing in number rapidly.

The increasing tendency of the apartment houses is considered as a result of coincidence between the government's housing policy, expecting the intensive utilization of limited land resources, and the change of people's selection consciousness about the type of dwelling from the detached houses (including the traditional Korean houses) to the more convenient and economical apartment houses. Because of these reasons, the increasing tendency of apartment houses is considered to continue.

Table II - 6 shows the characteristics of dwelling unit type by Gu. The Gu's in Zone I, Zone II and Zone III shared 75 percent or more to the detached dwelling. In Zone V, recent developing areas, the share of apartment house were 68 percent at Gangnam-Gu and 55 percent at Gangdong-Gu.

As the housing development projects of Mokdong area in Ganseo-Gu, Kaepo area in Gangnam-Gu and Kodok area in Gangdong-Gu progress in the near future, the share of apartment houses in these wards (Gu) will be expected to grow. In the developed areas, there is much possibility for increase of apartment houses by the redevelopment projects.

Table II - 5 Dwelling Units Construction

Classification / Year	Number of Dwelling Units Construction							Total Dwelling Units			
	Total	Type of Dwelling			Type of Organization			Total	Detached Dwelling	Apartment	Town House
		Detached Dwelling	Apartment	Town House	City	H.C	Private				
1980	47,447	8,995 (19.0)	24,573 (51.8)	13,879 (29.3)	5,000	4,548	37,899	1,006,390	727,888 (72.3)	202,835 (20.2)	75,667 (7.5)
1981	33,052	5,774 (17.4)	17,060 (51.6)	10,248 (31.0)	-	1,756	31,296	1,036,487	730,666 (70.5)	219,895 (21.2)	85,926 (8.3)
1982	49,534	9,473 (19.1)	23,321 (47.1)	16,740 (33.8)	3,000	10,056	36,478	1,085,631	736,071 (67.8)	246,894 (22.7)	102,666 (9.5)
1983	63,834	15,717 (24.6)	34,084 (53.4)	14,033 (22.0)	2,650	12,980	48,204	1,141,755	744,832 (65.2)	280,224 (24.5)	116,699 (10.2)
1984.3	7,804	1,549 (19.8)	5,393 (69.1)	862 (11.0)	-	1,680	6,124	1,148,059	744,929 (64.9)	285,569 (24.9)	117,561 (10.2)

Source: Urban Planning Division of Seoul Metropolitan Government

Note : The figures in parentheses indicate percentage of the total

Table II - 6 Dwelling Units by Gu (1980)

(Unit: thousand)

Classification / Gu	Total	Detached Dwelling	Apartment	Town House	Others[1]
Jongro	37	28	6	1	2
Jung	28	21	3	1	3
Zone I Total	65	49 (75)	9 (14)	2 (3)	5 (8)
Seongdong	66	57	3	4	2
Dongdaemun	86	69	8	5	4
Seongbug	66	60	3	2	2
Dobong	83	67	4	9	2
Zone II Total	301	253 (84)	18 (6)	20 (7)	10 (3)
Yongsan	41	26	12	1	2
Eunpyeong	46	40	1	4	2
Seodaemun	49	37	7	3	2
Mapo	51	40	3	6	2
Zone III Total	187	143 (76)	23 (12)	14 (7)	8 (4)
Ganseo	59	39	9	9	1
Guro	56	39	9	6	2
Yeongdeungpo	47	30	14	2	1
Dongjag	43	37	4	2	1
Gwanak	56	46	3	5	1
Zone IV Total	261	191 (73)	39 (15)	24 (9)	6 (2)
Gangnam	81	22	55	3	1
Gangdong	73	27	40	5	1
Zone V Total	154	49 (32)	95 (62)	8 (5)	2 (1)
Seoul City	968	685 (71)	184 (19)	68 (7)	31 (3)

Source: Korea Statistical Yearbook (1983)
: Data are based on 1980 Population and Housing Census.

Note : 1) Dwelling units in the building not intended for human habitation
2) The figures in parentheses indicate percentage of the total.

2-3 High Priority Relevant Plans

High priority relevant plans related to city planning of Seoul city are as follows:

- Fifth Five Year Economic and Social Development Plan
- Second National Land Development Plan
- National Capital Region Development Plan

The following is the outline of these plans.

(1) Fifth Five Year Economic and Social Development Plan

The initial two years of the Fifth Five Year Economic and Social Development Plan (1982-1986) was proceeded and revised in 1983 because of changes in various economic factors. This plan is the principal plan for the economy in the Republic of Korea, and the various practical economic goals and several targets that affect the city planning are presented. As for Seoul City, the target of dispersing the concentrated functions, population in particular in the national capital region, to the province is the most interested issue.

The strategies of controlling the concentration of the main urban functions in the national capital region and dispersing them to the province are as follows:

- Disperse the central administrative functions to other large cities (Taegu, Taejeon, Gwangju) in other provinces,
- Rearrange industries, preferentially to the local cities,
- Promote the transfer of public offices, universities, factories and so on to the provinces,
- Apply the Population and Traffic Impact Assessment System to the large scale development projects like the urban redevelopment projects,
- Control the establishment of factories in the national capital region, and

- Establish the National Capital Region Development Plan to promote these strategies effectively.

Based on these strategies, the National Capital Region Development Plan was established in 1984. The outline of this plan will be referred in a later section.

Seoul City is the largest city in the Republic of Korea, and its population occupies 23 percent of the national population in 1983. To successfully reflect the opinion of these people on the urban development policies and strategies, close cooperation between the national government and Seoul Metropolitan Government is necessary.

(2) Second National Land Development Plan

The Second National Land Development Plan (NLDP 2nd), published in 1982, is a general plan for national land development. This plan established the following general goals based on the general concept as shown in Fig. II - 3.

- Inducement of population settlements in the provinces,
- Enlargement of development possibilities in the whole country,
- Improvement of living standards, and
- Conservation of the national land and natural environment.

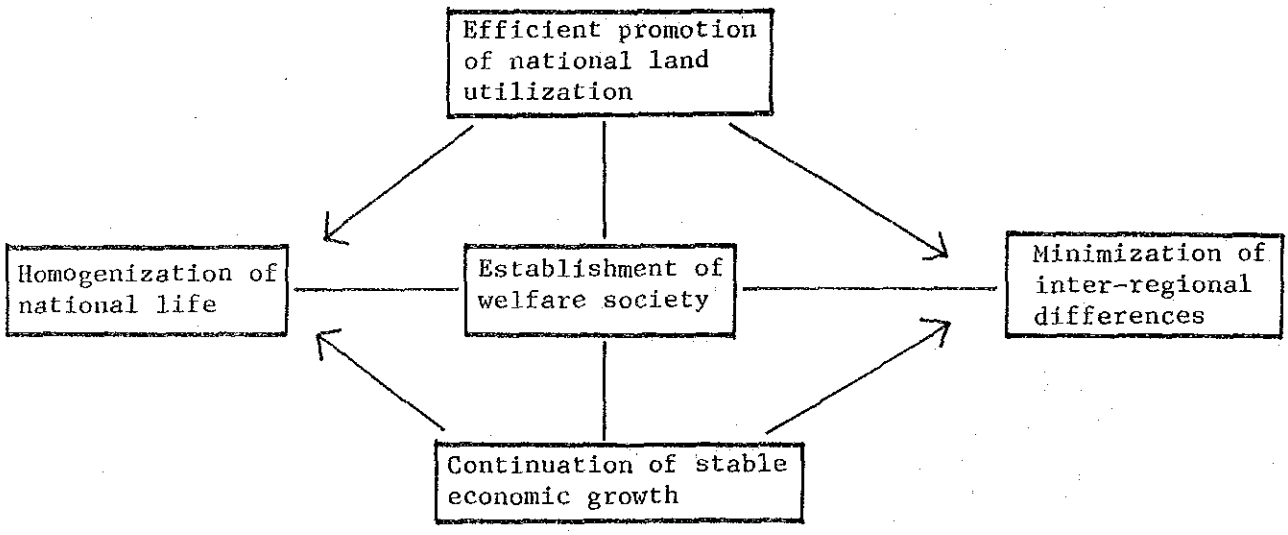


Fig. II - 3 General Concept of National Land Development

Based on these general goals, the strategies of national land development were established as follows:

- Formation of national land to a multi-core structure and establishment of regional biospheres,
- Control and management of growth in Seoul City and Pusan City, and
- Promotion of development in under-developed areas.

As evidently understood from these general goals and strategies, the basic policy for national land development plan is to decrease the inter-regional differences, especially between the big cities (like Seoul City and Pusan City) and the provinces. Therefore, the urban development policy based on these strategies is represented by the control of growth in big cities and the development of the provinces.

One of the most emphasized items related to Seoul City in the urban development policy of NLDP 2nd is the population control (Needless to say, this is related deeply to the urban area expansion control). Under the various preconditions concerning the population control policies, the population of Seoul City in 1991 was estimated to become 9,600 thousand persons. As mentioned in detail in a later section, the figure of the estimated population is likely to be underestimated. The basic policy of NLDP 2nd concerning Seoul City has been taken over by the National Capital Region Development Plan.

(3) National Capital Region Development Plan

The National Capital Region Development Plan (NCRDP) was established in 1984 succeeding a part of the Second National Land Development Plan. The purpose of the NCRDP is to remedy abuses resulting from over-centration of people and industries to establish a large efficient complex body in the national capital region. It consists of Seoul City, Incheon City and Kyeonggi Do. These regions are expected to be exploited according to its own regional characteristics to enable the inhabitants to enjoy a high quality living.

The National Capital Region Development Plan consists of a basic plan and an operational plan. The basic plan forms the framework of the

entire project, and explains the main items listed below.

- Structure and location of population and industry,
- Location of cities (with population over 50 thousand persons),
- Urban development Policy,
- Designation of areas (removal promoting area and so on),
- Environment conservation plan, and
- Plan of transportation facilities, water-works and sewerage facilities, etc.

The basic plan is formed and determined by the Minister of Construction, through various procedures. Besides, within the national capital region, any development plan which does not correspond to the contents of the national capital region development plan will not be admitted in principle.

The outline of the established national capital region development basic plan is as follows (the operational plan is not designated yet).

- Area of national capital region
  11,676 km^2 (Seoul City, Incheon City and Kyeonggi Do)
- Term of plan
  1982-1991 (10 years)
- General goal
  Inducement of the balanced development of national land by controlling over-concentration of population and industries in the national capital region and by dispersion of the urban functions.
- Basic strategies
  Promote the appropriate settlement of population and industries by the development strategies which are most suitable to each area (the national capital region is divided into 5 areas) and land use regulations in the wide sphere.
  (The classification and the basic development strategies of the 5 areas are shown in Table II - 7.)

As shown in Fig. II-4 , Seoul City is included in the removal promotion area, in which the development policies are indicated as follows:

- Promotion of the removal plan of factories, schools, offices, etc. and control of the construction of these facilities,
- Redevelopment of the urban areas,
- Control of building constructions,
- Practical use of the cleaned sites of the removed facilities and the evacuated, unpermitted buildings,
- Relief of the traffic congestion in the core areas, and
- Prohibition of establishing and extending the new organs of higher education and increasing the number of students.

These policies are likely to be useful for controlling the concentration of population and industries. However, these become more concepts unless the practical operational plan is established. Therefore, the operational plan with more detailed and practical means will need to be prepared as fast as possible.

Table II - 7 Basic Development Strategies by Area

Classification	Basic Development Strategy
Removal promotion area	Controlling the concentration of Population and industries
Restricted development area	Preventing the over-concentration of population and industries
Development inducement area	Inducing the removed facilities from other areas
Natural environment conservation area	Conservation of the Han River ba-basin
Development reserved area	Special development

Source The National Capital Region Development Basic Plan

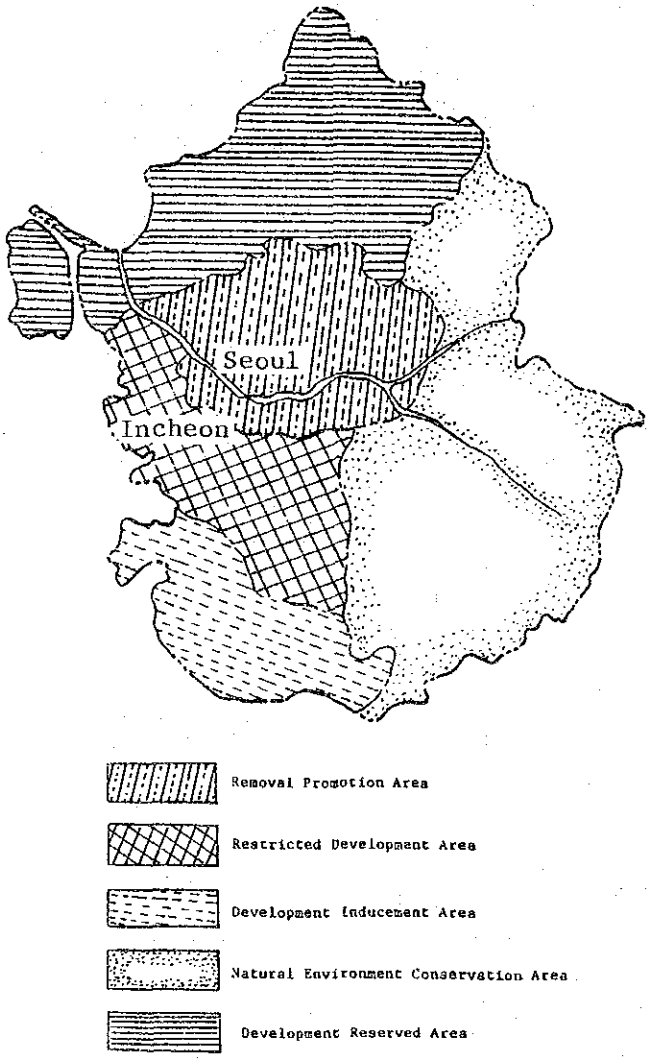


Fig. II - 4 Location of Areas

2-4 City Planning in Seoul City

(1) Outline

a. Contents of City Planning

The basic regulation which deals with city planning is the City Planning Law. The first step in city planning is the designation of a city planning area in accordance with the provisions of the Law. The city plans could be put into force only in a city planning area. Then according to the plans, the land use is controlled and the city planning projects could be implemented.

The main matters to be decided in the city plans are as follows:

- Zoning system for land use
- Urban facilities
- City planning projects

The contents of the zoning system are classified into 3 categories (Table II - 8). Category I defines the basic regulation for land use, which consists of residential districts (divided into three sub-districts), commercial districts, industrial districts (divided into three sub-districts) and green space districts (divided into two sub-districts).

The districts of category I are decided in the city planning area by the Minister of Construction. According to this classification, land use regulations are applied in conjunction with the other regulations on buildings.

The districts of Category II are planned in the case when more detailed regulations or land use are needed.

Category III is applied to the areas which need to be protected from the disordered development. Category III consists of four different areas, among which only the development restriction area is designated at present. The development restriction areas

Table II - 8 Contents of Zoning System

Category I	Category II	Cateogory III
o Residential district - Exclusively residential district - Quasi-residential district - Residential district o Commercial district o Industrial district - Exclusively industrial district - Quasi-industrial district - Industrial district o Green space district - Productive open space district - Natural green space district	o Scenic beauty conservation district o Beautiful sight conservation district o Building height control district o Fireproof district o District for education and research o Business district o Port district o Open space district o Conservation district o Special block development district o District for developing car parking facilities o Airport district o Natural environment conservation district o Apartment-house district	o Development restriction area (Green belt) o Special facility restrication area o Urbanization control area o Scheduled area for urban development

(commonly called a Green Belt) are designated in the large cities (Seoul, Pusan, Taegu, Gwangju and Taejeon) in order to prevent the disordered urban expansion.

The urban facilities to be planned in the city planning are defined as follows:

. Roads	. Libraries
. Open space	. Markets
. Car parking facilities	. Waterworks
. Motor vehicle terminals	. Sewerage facilities
. Rapid-transit railways	. Butcheries
. Rivers	. Cemeteries
. Canals	. Crematories
. Ports	. Electricity and gas supply facilities
. Airports	. Waste disposal facilities
. Parks	. Distribution business facilities
. Public office facilities	. Other facilities
. Schools	

As shown in the above list,waste disposal facilities are defined as urban facilities.

The city planning projects are divided into two kinds of projects. One of these is the projects to implement the individual urban facility, the other is the area-wide urban development projects. The latter consists of land readjustment projects, collective housing area development projects, collective industrial area development projects and urban redevelopment projects. Land readjustment projects have been carried out at many places in Seoul City. The urban redevelopment projects are being implemented in recent years.

b. Determination Procedure of a City Plan

The determination procedure of a city plan is shown in Fig. II-5. In priniciple, a city plan is formed by the local government (mayor or the head of Gun government), and is authorized by the Minister of construction.

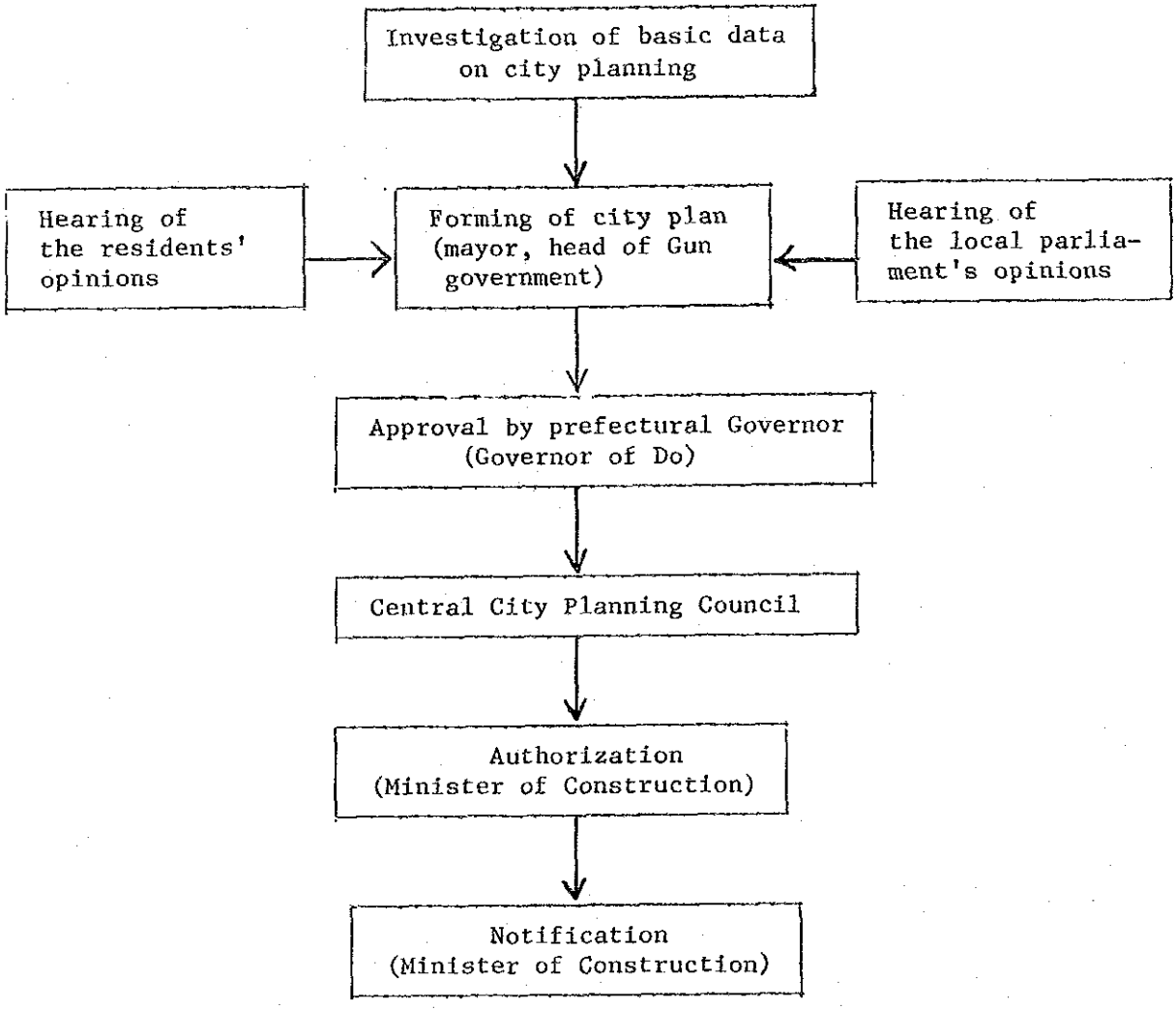


Fig. II-5 Determination Procedure of a City Plan

c. Basic City Plan

The basic city plan was added into the city planning law as an essential city planning subject in the 1981 revision. The objective of this plan is the indication of the long term (about 20 years) urban development policy. A mayor and/or a head of Gun

Government is under obligation to make this plan. The contents of the basic city plan are as follows:

1. Characteristics of city
2. Indices of city
3. Population plan
4. Land use plan
5. Transportation plan
6. Public facilities plan
7. Industrial development plan
8. Living environment plan
9. Parks and green space plan
10. Social development plan
11. Financial plan
12. Others

This plan is expected to encourage the present system of city planning in the Republic of Korea. The basic plan of Seoul City is now in planning and no formal information about this plan is available.

(2) City Planning in Seoul City

As mentioned in the preceding section, the city planning is in principle authorized and notified by the Minister of Construction through the consideration of the Central City Planning Council. Through the determining process of the original plan which is formed by the local government, compatibility with the related nation-wide plans of Fifth Five Year Economic and Social Development PLan, the Second National Land Development Plan, the National Capital Region Development Plan and others is one of the most important confirmation points. Therefore, whenever the nation-wide plans are established or revised, the review of the development plans in the related regions are required. In the case of Seoul City, the general development plan is not established at present. Moreover, the basic city plan, prescribed in the city

planning law, is not established either. As mentioned in the preceding section, the basic city plan is now in planning considering the compatibility with the newly established National Capital Region Development Basic Plan. At present, in Seoul City, the land use plan shown in the zoning system can be considered as the only available data which indicate the future land use.

The land use control based on Category I is the major element of the zoning system and it works in combination with use of the regulations on buildings, capacity ratios and building-to-land ratios, etc.

The districts of Category I in Seoul City are shown Table II - 9. Out of the 9 districts of Category I, 7 districts are indicated in Seoul City, except for the exclusively industrial districts and the industrial districts. The industries are concentrated in Guro-Gu which shares about 50 percent of the total industrial area (quasi-industrial districts). The decrease of industrial areas in Seoul City is expected with the advancement of the removal promotion policy in the National Capital Region Development Basic Plan.

The residential area has been expanding in Seoul City. The large scale housing development projects have started in the southern part of Seoul City, in Gangseo-Gu, Gangnam-Gu and Gangdong-Gu. The outline of these projects is shown in Table II-10. These new residential areas (including local parks and others) are scheduled to be accomplished within a few years.

More development projects are expected in the undeveloped areas, which have been running short year by year, based on the government's program. Among these undeveloped areas, Sanggye Dong (Dobong-Gu), Kimpo (Ganseo-Gu), Karak Dong (Gangdong-Gu) and Nanjido (Mapo-Gu) are very precious property for Seoul City, because they are the final open-spaces in the urban area. Therefore, thoughtful plans should be proposed in these areas.

Table II - 9 Plan of Zoning System (Category I) in Seoul City (Unit: ha)

Classification / Gu	City Planning Area	Residential District				Commercial District	Quasi-Industrial District	Green Space District		
		Exclusively Residential District	Quasi-Residential District	Residential District	Total			Productive Open Space District	Natural Green Space District	Total
Jongro	2,410	181	5	727	913	376	-	-	1,121	1,121
Jung	1,007	-	11	650	661	346	-	-	-	-
Zone I Total	3,417	181	16	1,377	1,574	722	-	-	1,121	1,121
Seongdong	4,082	74	22	2,239	2,335	22	293	-	1,432	1,432
Dongdaemun	3,132	-	15	2,168	2,183	144	1	-	804	804
Seongbug	2,483	81	20	1,735	1,836	6	-	-	641	641
Dobong	8,192	-	19	2,161	2,180	65	192	-	5,755	5,755
Zone II Total	17,889	155	76	8,303	8,534	237	486	-	8,632	8,632
Yongsan	2,138	53	6	1,095	1,154	127	-	-	857	857
Eunpyeong	3,275	-	30	1,349	1,379	6	-	-	1,890	1,890
Seodaemun	1,789	37	25	1,513	1,575	21	-	-	193	193
Mapo	2,381	-	34	1,062	1,096	26	-	-	1,259	1,259
Zone III Total	9,583	90	95	5,019	5,204	180	-	-	4,199	4,199
Ganseo	6,024	-	3	1,480	1,483	33	325	387	3,796	4,183
Guro	3,886	-	-	1,241	1,241	46	1,489	2	1,108	1,110
Yeongdeungpo	2,758	-	93	837	930	278	788	-	762	762
Dongjag	1,676	-	-	1,595	1,595	15	-	-	66	66
Gwanak	2,757	-	32	1,115	1,147	25	-	-	1,585	1,585
Zone IV Total	17,101	-	128	6,268	6,396	397	2,602	389	7,317	7,706
Gangnam	8,658	97	7	4,029	4,133	291	-	24	4,210	4,234
Gangdong	6,007	-	8	2,937	2,945	194	-	113	2,755	2,868
Zone V Total	14,665	97	15	6,966	7,078	485	-	137	6,965	7,102
Total	62,655	523	330	27,933	28,786	2,021	3,088	526	28,234	28,760

Source: Urban Planning Division of Seoul Metropolitan Government

Table II-10 Special Area Development Projects

Classification / Name of Special Area	Project Area (Km^2)	Planned Population (x1000)	Land Use Plan		
			Commercial Zone (Km^2)	Residential Zone (Km^2)	Others (Km^2)
Mok Dong	4.3	120	0.462	2.314	1.524
Kodok	3.355	79	0.085	3.261	0.009
Kaepo	8.938	170	0.450	2.357	6.131

Source: Urban Planning Division of Seoul Metropolitan Government

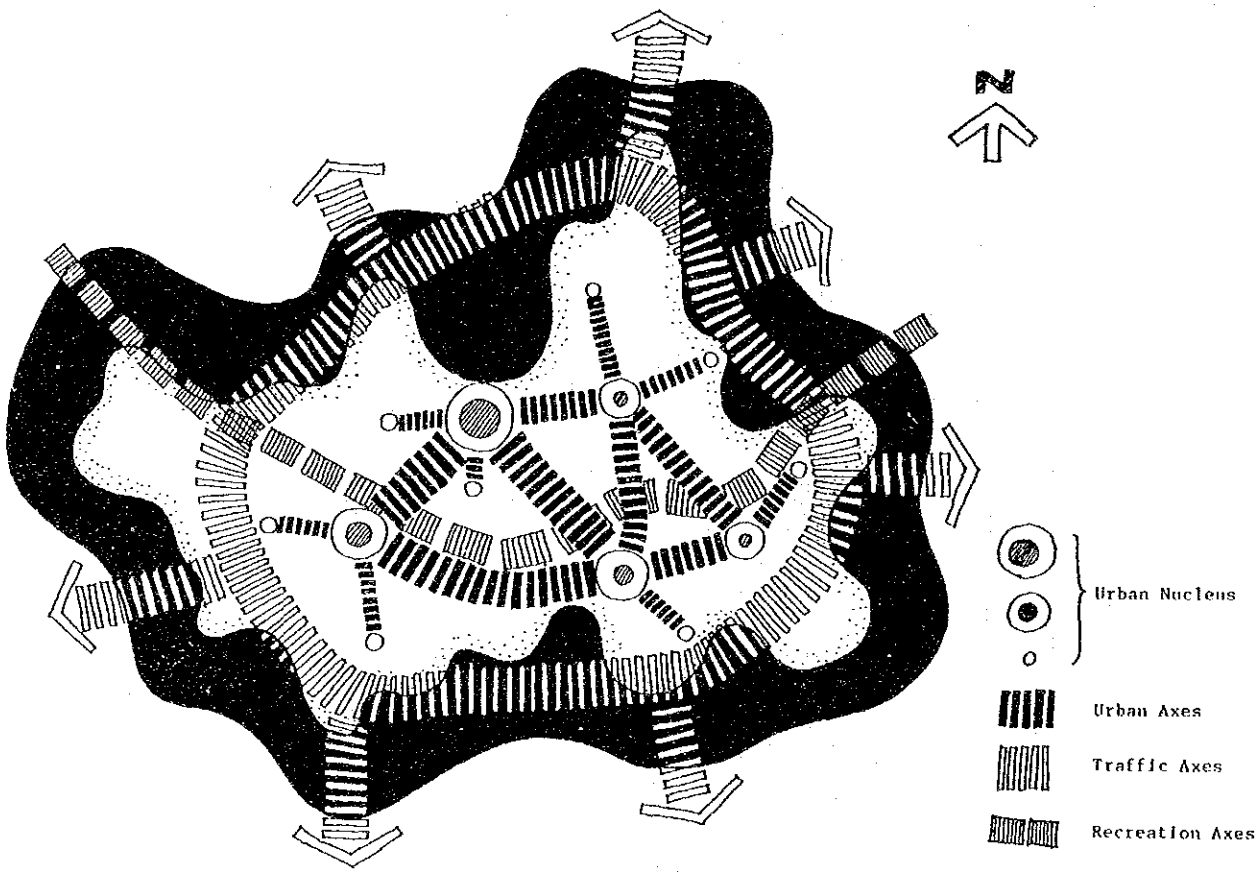


Fig. II-6 Concept of City Planning in Seoul City

3. POPULATION

3-1 Past and Present Population

(1) National Population

The population of the Republic of Korea in 1983 was about 40 million (39,951 thousand people). The population density was 404 persons per km^2, which is one of the highest densities in the world. (The People's Republic of China, 105 per/km^2 (1981); Japan, 316 per/km^2 (1981); the Philippines, 165 per/km^2 (1981); Hong Kong, 4,932 per/km^2 (1981); Singapore, 4,205 per/km^2 (1981); Indonesia, 79 per/km^2 (1981); India, 208 per/km^2 (1981)). The annual population growth rate decreased continuously from 1961 up to 1979, but in 1980 it increased slightly. And since 1980, it has been stable. The population trend of Korea is indicated in Table II-11. The annual growth rates for Korea are plotted in Fig. II-7.

The annual population increase rate of 1.58% is rather high compared with those of the developed countries (U.S.A., 1.0% (1975-1981); Great Britain, 0.0% (1975-1981); West Germany 0.0% (1975-1981); France, 0.4% (1975-1981); Japan, 0.9% (1975-1981)).

In spite of the government's efforts to reduce the high population increase rate, the tendency is not changed and has become one of the serious problems for the Republic of Korea as her land resource is limited.

Table II-12 show that the speed of population concentration into the urban areas is remarkably high. In Seoul City and Pusan City, urban problems have been occurring owing to the rapid process of overpopulation.

Table II-11 National Population Increase by Year

(Unit: thousand persons)

Year	Population	Population increase	Rate of increase (%)
1974	34,692	589	1.73
1975	35,281	589	1.70
1976	35,849	568	1.61
1977	36,412	563	1.57
1978	36,969	557	1.53
1979	37,534	565	1.53
1980	38,124	590	1.57
1981	38,723	599	1.57
1982	39,331	608	1.57
1983	39,951	620	1.58

Source: Korea Statistical Yearbook (1983)

Note : Estimates of midyear population

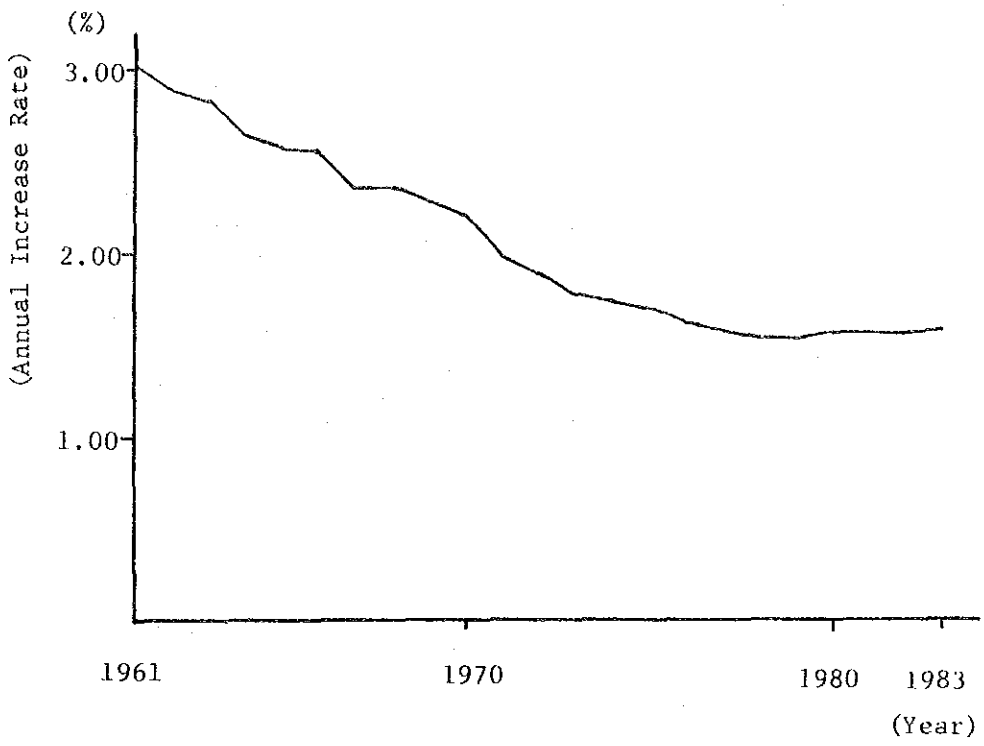


Fig. II-7 Annual Population Increase Rates in Korea

Table II-12 Trend of Population Concentration Rates to the Urban Areas

(Unit: thousand person)

Classification \ Year	1955	1960	1966	1970	1975	1980
National Population (A)	21,502	24,989	29,160	31,434	34,677	38,124
Urban Population[1] (B)	6,488	8,947	12,277	15,652	20,240	25,428
Rural Population	15,014	16,042	16,883	15,782	14,437	12,696
Rate of Urban Population (B)/(A)	30.2	35.8	42.1	49.8	58.4	66.7

Source: Second National Land Development Plan, Korea Research Institute for Human Settlements

Note 1/: Populations in towns and cities which have over 20 thousand population are counted.

(2) Population in Seoul City

a. Trend of Population

The population of Seoul City changed greatly several times in the past with historical fate. In the 1960's, the rapid economic growth was promoted together with the stabilization of the social structure. What made a great contribution to the economic growth was the industies, mainly the secondary industries induced into Seoul City.

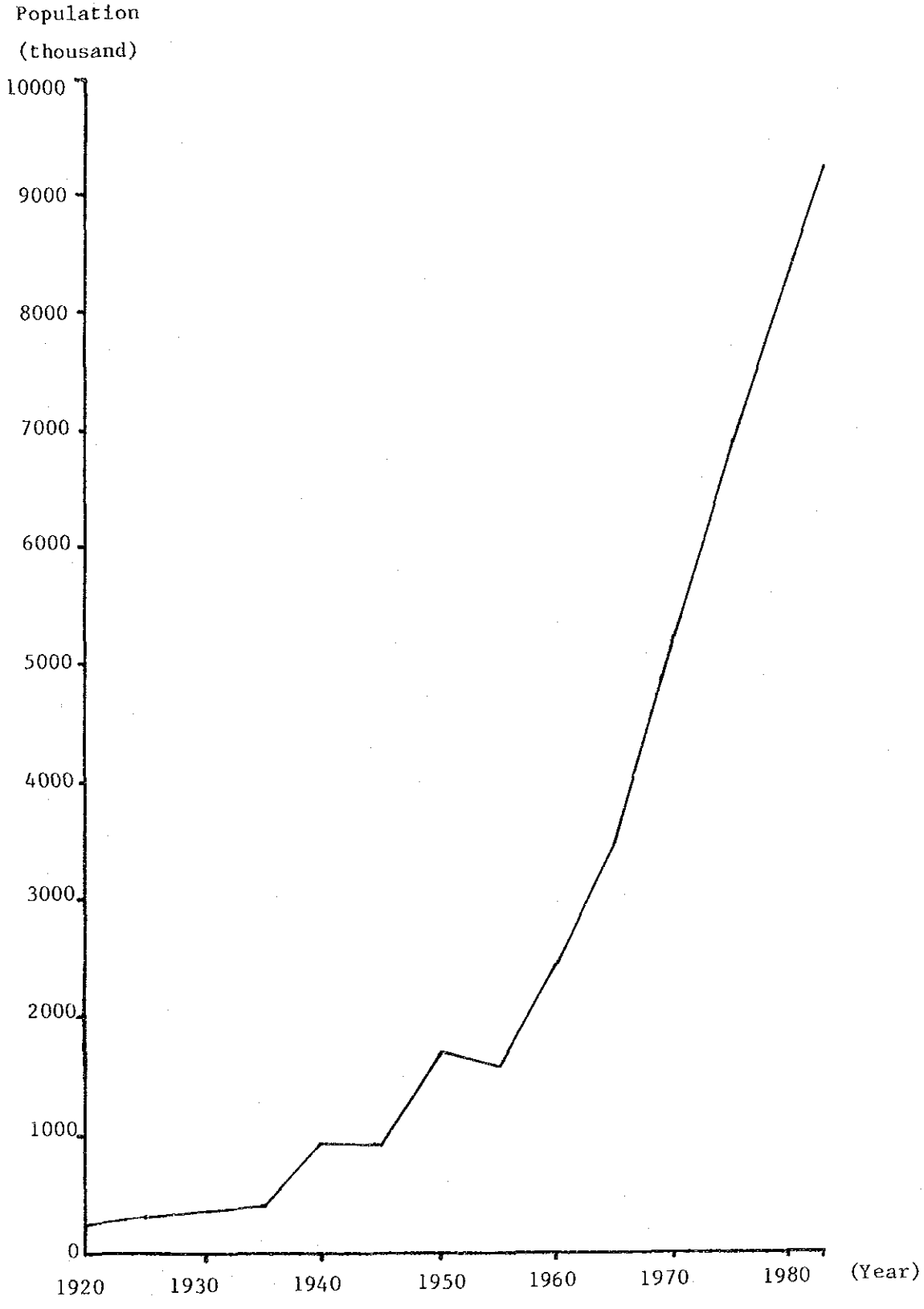
The improvement of the income level, cultural standard, and educational and urban facilities accompanied by the economic growth contributed to the population concentration into Seoul City. The population of Seoul City increased above 3 million during a decade of 1960's. The 1960's could be said to be an era of foundation for development and the 1970's was an era for the great development.

Based on the success of the economic development, intensive urban development was achieved in the 1970's. Through this the structure of Seoul City was formed. The 1970's was then an era of construction.

However, the rapid economic development caused the population concentration, and the big city problems, especially population problems, became distinct. Therefore, from the latter half of the 1970's, the control of the population became a big subject.

In the 1980's, the population increase rate showed a downward trend. The increase from 1980 to 1983 was about 800 thousand, which is not a low figure. The population in 1983 was 9,200 thousand. If the increasing trend continues toward the end of the 1980's, the population of Seoul City will possibly reach 10 million.

The urban problems have become more serious and more complicated with the population growth. Therefore, the promotion of the drastic population control policy is becoming more important.



Source: Handbook (1983) of Seoul Metropolitan Government

Fig. II - 8 Trend of Population in Seoul City

Table II-13 Population Increase by Period

Year	Period (Years)	Population Increase (1000 persons)	Population (1000 persons)
1920-1945	25	651	1920: 250
1945-1960	15	1,544	1945: 901
1960-1970	10	3,080	1960:2,445
1970-1980	10	2,842	1970:5,525
			1980:8,367

Source: Handbook (1983) of Seoul Metropolitan Government

Table II-14 Speed of Population Increase

Population Increase (million)	Years Required to Increase a Million Persons	Period
100-200	17 years	1942-1959
200-300	4	1959-1963
300-400	5	1963-1968
400-500	2	1968-1970
500-600	2	1970-1972
600-700	4	1972-1976
700-800	3	1976-1979
800-900	4	1979-1983

Source: Handbook (1983) of Seoul Metropolitan Government

b. Natural Increase and Social Increase

The natural increase of population in Seoul City was about 150,000 in 1982 (Table II-15). The birth rate (births per 1,000 persons per year) in Seoul City was 20-22 ‰ in 1980-1982, and the mortality rate (deaths per 1,000 persons per year) was 3-4‰ in 1977-1982. Both of them showed lower figures than those of the nation (Birth rate: 23.4 ‰; Mortality rate: 6.6 ‰ in 1981).

The social increase of population in Seoul City was about 130,000 in 1982 (Table II-16). The recent trend shows a tendency to decline. A reason for this decline is the increase of out-migration from the city. Recently, the number of in-migration has remained about the same, and on the other hand, that of out-migration has been increasing yearly. If such a tendency continues, it is possible that the social increase will become zero at the end of the 1980's.

The characteristics of the inter-province migration show that the figures of out-migration from Seoul City to Kyeonggi Do is greater than that of in-migration from Kyeonggi Do to Seoul City (Fig. II-10). This phenomenon is perhaps caused by the housing shortage in Seoul City, the expansion of the so-called commuter zone by the development of transportation, and the removal of government offices from Seoul City to Kyeonggi Do.

Such a tendency is expected to grow with the progress of overpopulation in Seoul City. Therefore, the policy to prevent beforehand the growth of urban problems around Seoul City become more important and an urgent subject.

Table II-15 Number of Births and Mortalities

(Unit: thousand persons)

Year	1976	1977	1978	1979	1980	1981	1982
Birth	137	123	121	153	174	186	182
Birth Rate (‰)	18.9	16.3	15.5	18.9	20.8	21.4	20.4
Mortality	17	24	24	24	29	31	29
Mortality Rate (‰)	2.3	3.2	3.1	3.0	3.5	3.6	3.3
Natural Increase	120	99	97	129	145	155	153

Source: Seoul Statistical Yearbook

Table II-16 Migration

(Unit: thousand persons)

Year	1976	1977	1978	1979	1980	1981	1982
In-migration	715	681	789	706	782	769	797
Out-migration	454	466	511	558	617	621	665
Net-migration	261	215	279	148	165	148	132

Source: Seoul Statistical Yearbook, Korea Statistical Yearbook

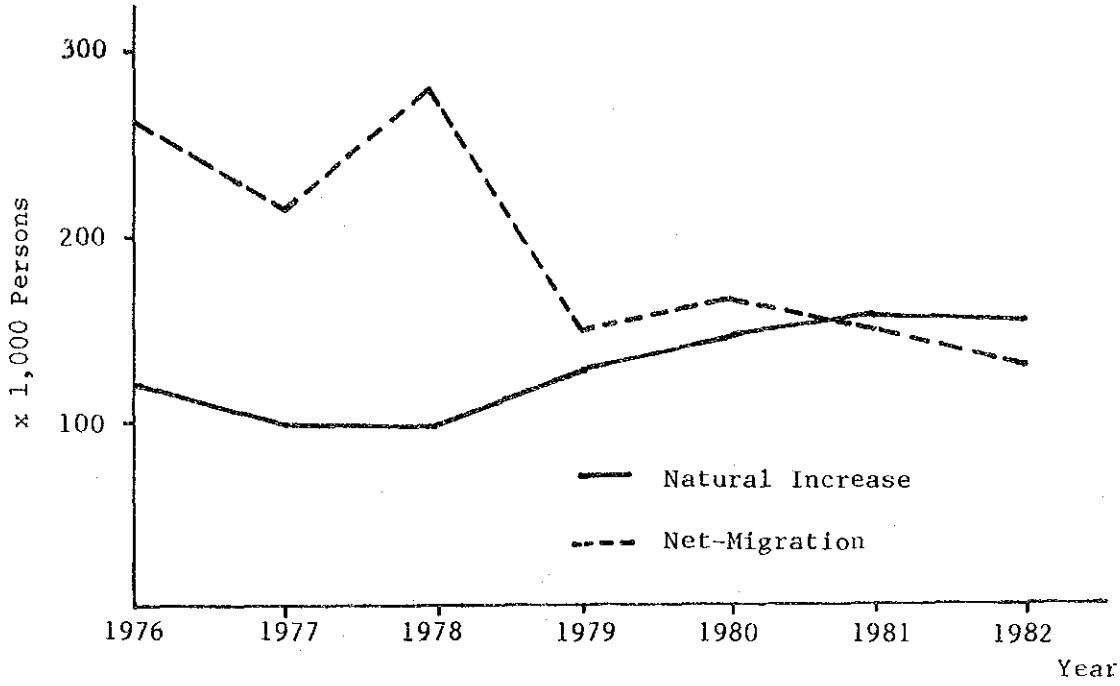
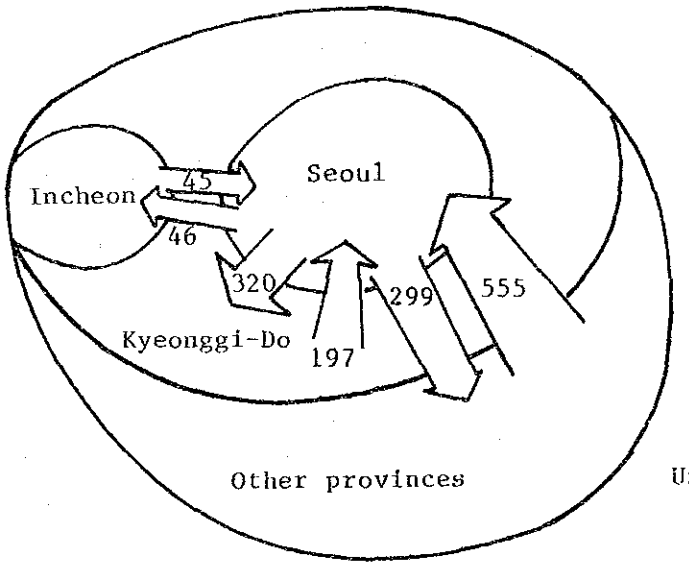


Fig. II - 9 Natural Increase and Net-Migration



Unit: thousand persons

Source: Korea Statistical Year book 1983

Fig. II-10 Inter-Province Migration

c. Population by Zone and Gu

The populations by zone and Gu are shown in Table II-17. In the area of the central business district, Jongro-Gu and Jung-Gu (Zone I), population has been declining. On the other hand, the developing areas in the southern part of Seoul City, Gangnam-Gu and Gangdong-Gu (Zone V) show extreme growths of population. In this area, the population increased 3 times from 1975 to 1983. Populations of the other zones have also been increasing but the increasing trend is not as sharp as that of Zone V.

Through the 1980 Population and Housing Census of the Republic of Korea, the daytime population by zone and Gu was estimated (Table II-18). The ratio of daytime population to resident population is very high in Zone I (Jongro-Gu and Jung-Gu). Such a high ratio is a typical characteristic of a central business district.

As for the whole Seoul City, the daytime population is about 80,000 persons more than that of the resident population. In the future, as a result of the expansion of the commuter zone, the difference between the daytime population and the resident population is expected to become greater.

Table II-17 Population by Gu

(Unit: thousand persons)

Gu \ Year	1975	1976	1977	1978	1979	1980	1981	1982	1983
Jongro	334	330	322	312	299	292	292	289	277
Jung	285	285	275	260	250	242	239	233	225
Zone I Total	619	615	597	572	549	534	531	522	502
Seongdong	630	640	641	660	671	689	709	717	737
Dongdaemun	738	754	781	793	823	848	868	889	914
Seongbug	605	614	596	593	592	589	590	588	589
Dobong	632	663	690	708	728	753	775	791	813
Zone II Total	2,605	2,671	2,708	2,754	2,814	2,879	2,942	2,985	3,053
Yongsan	337	339	347	344	340	333	337	337	335
Eunpyeong	-	326	336	371	379	383	403	413	422
Seodaemun	796	486	469	438	422	420	422	424	423
Mapo	422	430	437	437	434	433	439	439	439
Zone III Total	1,555	1,581	1,589	1,590	1,575	1,569	1,601	1,613	1,619
Ganseo	-	245	353	408	456	501	542	581	635
Guro	-	-	-	-	-	569	595	611	630
Yeongdeungpo	1,051	920	910	953	988	431	441	444	446
Dongjag	-	-	-	-	-	393	392	398	400
Gwanak	623	667	723	782	823	503	515	526	540
Zone IV Total	1,674	1,832	1,986	2,143	2,267	2,397	2,485	2,560	2,651
Gangnam	437	326	388	368	464	475	528	582	652
Gangdong	-	232	259	396	444	512	589	654	727
Zone V Total	437	558	647	764	908	987	1,117	1,236	1,379
Seoul City	6,890	7,255	7,526	7,823	8,114	8,367	8,676	8,916	9,204

Source: Seoul Statistical Year Book (1975-1982)
Seoul Metropolitan Covernment (1983)

Note: Since the boundary between Gwanak and Gangnam has slightly changed in 1980, the populations from 1975 to 1979 were proportionally distributed by area.

Table II-18 Daytime Population (1980)

(Unit: thousand persons)

Classification / Gu	Commuting Population			Daytime Population	Ratio of Daytime Population to Resident Population (with resident Population as 100)
	In flow (A)	Out flow (B)	(A)-(B)		
Jongro	335	125	210	502	171.9
Jung	467	91	376	618	255.4
Zone I Total	802	216	586	1,120	209.7
Seongdong	250	265	-15	674	97.8
Dongdaemun	292	338	-46	802	94.6
Seongbug	178	237	-59	530	89.9
Dobong	186	293	-107	646	85.8
Zone II Total	906	1,133	-227	2,652	92.1
Yongsan	197	127	70	403	121.0
Eunpyeong	96	148	-52	331	86.4
Seodaemun	173	179	-6	414	98.6
Mapo	121	178	-57	376	86.8
Zone III Total	587	632	-45	1,524	97.1
Ganseo	106	177	-71	430	85.8
Guro	202	216	-14	555	97.5
Yeongdeungpo	230	172	58	489	113.5
Dongjag	126	162	-36	357	90.8
Gwanak	109	191	-82	421	83.7
Zone IV Total	773	918	-145	2,252	94.0
Gangnam	151	180	-29	446	93.9
Gangdong	130	192	-62	450	87.9
Zone V Total	281	372	-91	896	90.8
Seoul City	3,349	3,271	78	8,444	100.9

Source: 1980 Population and Housing Census Report, National Bureau of Statistics, Economic Planning Board

d. Household

The number of households and the persons per household in Seoul City are shown in Table II-19. The number of households reached 2 million in 1982 after a stable increase. On the other hand, the persons per household showed a tendency to decline. It was 4.5 in 1982. However, this figure is larger yet compared with those of the developed countries (U.S.A.: 2.9 (1977); Canada:3.2 (1976); France:2.9 (1975); Australia:3.1(1976); Japan:3.2(1980)).

In the future, it is expected that the family size will decrease because the births per woman is likely to decrease, and also due to the change in mode of life with the increase of nuclear families.

Table II-19 Number of Households in Seoul City

(Unit : Thousand)

Year	1975	1976	1977	1978	1979	1980	1981	1982
Number of households	1410	1461	1529	1609	1713	1842	1915	2001
Persons per household (Persons/ household)	4.9	5.0	4.9	4.9	4.7	4.5	4.5	4.5

Source : Seoul Statistical Year Book

3-2 Governmental Policy on Population

Population control has become a serious subject for many nations in the world, especially in the developing countries. The fourth International Conference on Population was held in August, 1984 in Mexico City. The "Mexico declaration on population and development" was adopted under the recognition that a challenge on a global scale was indispensable.

In Korea, population control is an outstanding issue that deserves high priority in the national plans. Outlines of the population policies in the national plans relevant to Seoul City are explained here.

(1) Fifth Five Year Economic and Social Development Plan

The Fifth Five Year Economic and Social Development Plan shows the greatest interest in the control of population increase as one of its major strategies. The means to control the population increase such as a family planning program and the improvement of people's preference for a son are mentioned in this plan. The plan also puts a target on control of the concentration of population into the national capital region. Removal of the primary urban functions to the province is one of the general targets for the balanced development of the nation and for the improvement of the living environment. (To promote these policies, the National Capital Region Development plan was established in 1984.)

Presented in Table II-20 is the estimated future national population which objective is to reduce the increase rate in annual population. As was mentioned previously, the population increase rate has been stabilizing since 1979 without showing a decreasing tendency. Therefore, to accomplish the objective of declining the annual population increase rate to 1.49 percent by 1986, and 1.38 percent by 1988, stronger promotion of the population control policy is required.

Table II-20 Estimated Nation's Future Population

Classification	Unit	Year	
		1986	1988
Population	thousand persons	41,839	43,073
Population Increase Rate	%	1.49	1.38

Source : The Fifth Five Year Economic and Social Development Plan (Revised Plan)

(2) Second National Land Development Plan

In the Second National Land Development Plan, the balanced development is a basic concept. Based on this basic concept, various general targets concerning the national land development are presented. One of them is the inducement of the population settlement in the rural area. As strategies to achieve this target, the population control in Seoul City and migration of people into the core-city in the rural area are promoted.

The future population of Seoul City is planned to be 9.6 million in 1991. This figure was calculated assuming that 2.3 million people out of 11.9 million (projected future population) would be removed to the province.

Inducement of population from Seoul City to the province is to control the population concentration in Seoul City. There are two main means to control the population concentration. One is prevention of the urban expansion by land use regulation, and the other is to remove the factors causing the population concentration.

As for the land use regulation, setting the development restriction area has been working well. Keeping the development restriction area is one of the important subjects of urban policy of Seoul City. As the outskirts of the urban area in Seoul City are mountainous, the development restriction would work effectively to some extent.

Removal of population concentration factors, e.g., control of establishment and extension of the universities and factories, etc. has been carried out since the 1970's. But it has not reached the satisfactory grade yet.

(3) National Capital Region Development Plan

The population control policy in the National Capital Region Development Plan is similar to that of the Second National Land Development Plan. This plan explains not only the necessity of control of Seoul's population, but the countermeasures for population concentration in the overall national capital region. In this plan, the future population is estimated as 9.9 million in 1991 and 10.0 million in 2001.

Table II-21 Government Plan for Future Population in Seoul City

(Unit: thousand persons)

	Existing Data	Planned Population		
	1983	1986	1991	2001
Second National Land Development Plan (1982)	9,204	9,200 (-0.01)	9,600 (0.85)	[9,900] (0.31)
National Capital Region Development Basic Plan (1984) 1)		9,500 (1.06)	9,800 (0.62)	10,000 (0.20)
Han River Basin Environmental Master Plan (Draft Report) (1983)		9,780 (2.04)	10,800 (2.00)	12,130 (1.17)

Note: 1) The future population plan to be authorized by Seoul Metropolitan Government is now in planning and no formal information is available.

According to the provisions of the National Capital Region Development Planning Law, any development plans which do not correspond to the contents of the National Capital Region Development Basic Plan will not be admitted in principle. Therefore, the future population plan to be prepared by Seoul Metropolitan Government will be assumed to be similar to that of the National Capital Region Development Basic Plan.

2) The parentheses indicate the annual increase rate

3-3 Population Projections

In general, population forecasts and population planning are not the same. The indicative population planning established by the government on some plans is decided principally from a standpoint of a population policy referring to the projected population. The result of the projection is not always utilized directly for the population planning. In this study, the estimation of the future population was carried out in consideration of the indicative population by the government and the estimated population from other projects. In particular, it was considered that a more practical figure should be estimated because of the characteristics of this study. The estimate will be used for the projection of the waste generation rate. Based on the projected waste generation rate, the scale of the intermediate processing facilities, etc. will be determined.

(1) Projections

To project the population, two methods are generally used. One is by trend analyses using equations such as arithmetic growth formulas, geometric growth formulas, exponential growth formulas, logarithmic growth formulas, and logistic curve formulas. The other is an age cohort survival method.

The age cohort survival method is usually used in the projection of national population which generally shows the stabilized trend based on natural increase. In the case of limited areas, especially in areas which show large scale migrations like Seoul City which had about 1.5 million migrators per year, the cohort method is not always useful. This method requires numerous assumptions concerning biological factors.

In this study, some trend analyses were carried out. To utilize this method, the continuation of the trend must be studied carefully. It is necessary that the factors affecting the population increase be stable.

In Seoul City, although the measures for population control have been promoted since the 1970's, problems such as those on housing, traffic and environment are becoming more serious. In the future, population control of Seoul City will be more important as its capacity is limited. In the trend analyses of this study, data from 1975 to 1983 were used, as during this period, the effects of the population control became apparent as is shown in Fig. II-11.

Table II-22 Annual Population Increase Rate

(Unit: %)

Year	Annual Population Increase Rate
1963-1964	5.22
1964-1965	1.36
1965-1966	9.29
1966-1967	4.64
1967-1968	9.21
1968-1969	10.20
1969-1970	15.66
1970-1971	5.89
1971-1972	3.85
1972-1973	3.51
1973-1974	4.01
1974-1975	5.32
1975-1976	5.30
1976-1977	3.74
1977-1978	3.95
1978-1979	3.72
1979-1980	3.12
1980-1981	3.69
1981-1982	2.77
1982-1983	3.23

Source: Seoul Statistical Year Book
Urban Planning Division of Seoul Metropolitan Government

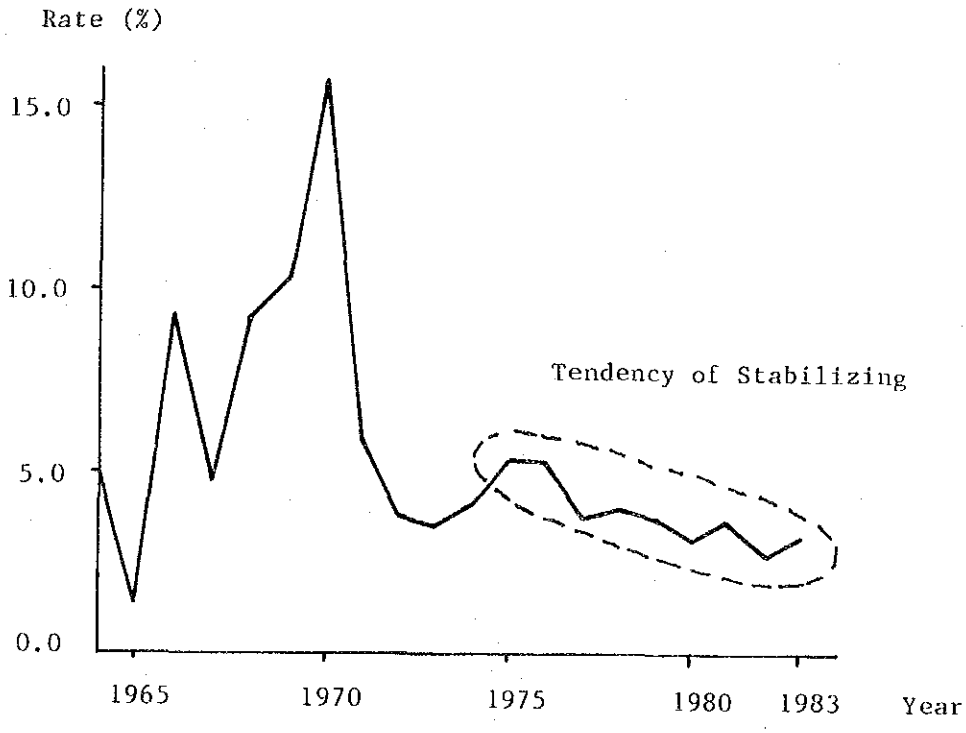


Fig. II-11 Annual Population Increase Rates in Seoul City

a. Arithmetic Growth Formulas

Based on an assumption that the annual average increase of population was carried out. As judged from the trend in the past and the expected promotion of population control in the future, the results of this method indicate the upper limit. It is close to the projection made by the United Nations in 1978 at about 13.7 million in 2001.[1/]

(Unit: thousand persons)

Year	1983	1988	1991	2000	2001	2005
Population	9,204	10,648	11,502	14,065	14,349	15,488
(Growth %)		(2.96)	(2.60)	(2.26)	(2.02)	(1.93)

Formula for projection $P = 6,662 + 284.7T$

where, P: Population
T: Term

1/ Source: U.N., Urban, Rural and City Population, 1950-2000

b. Logarithmic Growth Formulas

In consideration of the reclining tendency of the population increase, the projection by the use of logarithmic growth formulas was carried out.

(Unit: thousand persons)

Year	1983	1988	1991	2000	2001	2005
Population	9,204	10,386	11,041	12,781	12,957	13,630
(Growth %)		(2.45)	(2.06)	(1.64)	(1.38)	(1.27)

Formula for projection where, P: Population

$P = -271982.2 + 9931.8 \log_e T$ T: Term

c. Logistic Curve Formulas

The projection by the method of logistic curve formulas is often utilized to take into consideration the limits of growth.

(Unit: thousand persons)

Year	1983	1988	1991	2000	2001	2005
Population	9,204	10,567	11,113	12,246	12,332	12,619
(Growth %)		(2.80)	(1.69)	(1.08)	(0.70)	(0.58)

Formula for projection where, P: Population

$$P = \frac{13330.4}{1+0.925366\ \exp(-0.0902536T)}$$ T: Term

d. Exponential Growth Formulas for Annual Population Increase Rate

The annual population increase rates were calculated from past annual population increase data by applying the exponential growth formulas (See Table II-23). Then from the expected annual population increase rates, the future populations are projected.

(Unit: thousand persons)

Year	1983	1988	1991	2000	2001	2005
Population	9,204	10,327	10,880	12,078	12,176	12,512
(Growth %)		(2.33)	(1.75)	(1.17)	(0.81)	(0.68)

Formula for Projection where, R: Annual Increase Rate

$R = 5.374 \exp(-0.07009T)$ T: Term

Table II-23 Projected Annual Population Increase Rate

(Unit: Percent)

Year	Annual Population Increase Rate	Year	Annual Population Increase Rate
1974 - 1975	5.32	1990 - 1991	1.63
1975 - 1976	5.30	1991 - 1992	1.52
1976 - 1977	3.74	1992 - 1993	1.42
1977 - 1978	3.95	1993 - 1994	1.32
1978 - 1979	3.72	1994 - 1995	1.23
1979 - 1980	3.12	1995 - 1996	1.15
1980 - 1981	3.69	1996 - 1997	1.07
1981 - 1982	2.77	1997 - 1998	1.00
1982 - 1983	3.23	1998 - 1999	0.93
1983 - 1984	2.67	1999 - 2000	0.87
1984 - 1985	2.49	2000 - 2001	0.81
1985 - 1986	2.32	2001 - 2002	0.76
1986 - 1987	2.16	2002 - 2003	0.70
1987 - 1988	2.01	2003 - 2004	0.66
1988 - 1989	1.88	2004 - 2005	0.61
1989 - 1990	1.75		

Note : Figures after 1983 are projections.

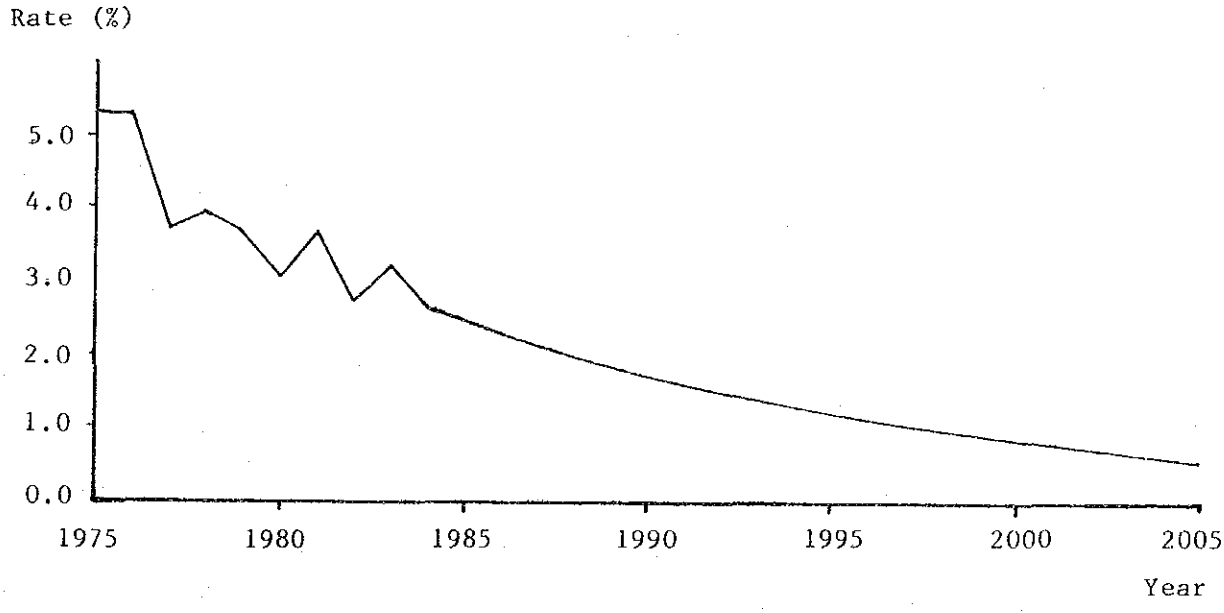


Fig. II-12 Trend of Projected Annual Population Increase Rate

(2) Land Capacity

A city is like a living thing; it never stops growing. Two kinds of growth patterns can be conceived. One is the growth in quantity and the other is in quality. As the cities grow, they create their individual fascination, and on the contrary, they may possess their own problems.

It is common that the serious city problems restrict the growth of cities since the big cities around the world have experienced similar phenomena. At this point, the cities tend to change their pattern of growth from quantity-oriented to quality-oriented.

In the case of Seoul City, judging from the physical conditions of the land capacity and the existing city problems, it is possible to say that the time to change the growth pattern has now come. However, since it is impossible to stop the population growth suddenly, besides promoting the change towards a high quality city, countermeasures should be sought to control the population growth. Under the condition of limited land resources as in Seoul City, how to utilize the land efficiently is a very important subject. Efficient land utilization helps in the progress for a better quality city.

One of the indicators which shows the efficiency of land utilization is the population density. In general, population density is calculated based on the planned land use. As for the residential zone, 100-400 persons per hectare is common in urbanized areas; 100 per/ha is usual in low density, detached house areas; 400 per/ha is found in intensive land utilization areas like the apartment house zone.

In the case of Seoul City, as shown in Table II-24 , the population density is relatively high. The population density of Seoul City reached 300 persons per hectare in developed areas. Such a high density indicates the high efficiency of land utilization in a sense if there are no serious problems due to overpopulation in those areas. Of course in the apartment area, 300 per/ha is not extremely high, and there are no serious problems caused by high population density.

Table II-24 Estimated Population Increase in Future Developing Areas

Gu	Population Density in Administrative Area (1983)	Population Density in Developed Area	Undeveloped Area (Future Developing Area)	Estimated Population Density for Future Developing Area[1)]	Estimated Population Increase in Future Developing Area
Jongro	114 P/ha	226 P/ha	33 ha	250-300	8-10 x 1000P
Jung	223	270	2	250-300	1
Zone I Total	147	244	35	250-300	9-11
Seongdong	181	266	270	350-400	95-108
Dongdaemun	292	431	165	350-400	58-66
Seongbug	237	435	89	350-400	31-36
Dobong	99	308	1237	300-350	371-433
Zone II Total	171	343	1761	320-370	555-643
Youngsan	157	220	13	350-400	5
Eunpyeong	129	326	54	350-400	19-22
Seodaemun	236	314	46	350-400	16-18
Mapo	184	350	505[2)]	350-400	72-82[3)]
Zone III Total	169	299	618	350-400	112-127
Ganseo	105(125)	245(292)	972	300-350	292-340
Guro	160	237	173	350-400	61-69
Yeongdeungpo	162	243	82	350-400	29-33
Dongjag	239	397	29	350-400	10-12
Gwanak	196	388	41	350-400	14-16
Zone IV Total	155	280	1297	310-360	406-470
Gangnam	75(95)	202(254)	1195	300-350	359-418
Gangdong	121(134)	291(323)	957	300-350	287-335
Zone V Total	94	241	2152	300-350	646-753
Total	147(153)	291(303)	5863	310-360	1728-2004

Note: 1) Estimated by the study team
2) Including Nanjido solid waste disposal site (approximately 300 hectares)
3) Excluding Nanjido solid waste disposal site
4) The figures in parentheses are population densities in the case of adding the planned populations in the special area development projects; mokdong, kaepo and kodok.

The land capacity of Seoul City is estimated here under the following conditions:

- the expansion of the urban area is not taken into consideration
- the existing land regulations are respected
- population density in undeveloped areas is estimated to reach 250-400 per/ha after development (Table II-24). The estimation of population density by Gu was carried out considering the population density in the developed areas and also the scale of the development areas in the future. (Generally the population density in large scale developments is lower than that of small scale developments.)
- in the undeveloped areas, it is assumed that mostly multi-storyed buildings will be built in the future.

The result of the estimation of land capacity was estimated to be about 11.3-12.0 million as shown in Table II-25 .

Table II-25 Land Capacity of Seoul City

(Unit: thousand persons)

Developed Area	Developing Area	Undeveloped Area (Future Developing Area)	Total
9,204-9,664 1)	369 2)	1,728-2,004	11,301-12,037

Note: 1) Possibility of the capacity increase (0-5%) by urban renewal is taken into consideration.

2) The planned populations of the development projects in Mokdong, Kaepo and kodok.

(3) Estimated Future Populations for this Study

The future population in Seoul City studied from various viewpoints are summarized in Table II-26 and Fig. II-13. As clearly shown in Fig. II-13, the population planned by the government is very small compared to the other figures. The planned population was determined based on the government's population policy to control the population concentration into Seoul City in consideration of the land capacity. Judging from the present population and the increasing trend in recent years, it is quite possible that the future population will go beyond the government's planned population even if any population control policy, as mentioned in a former subsection, is promoted.

Table II-26 Future Populations in Seoul City

(Unit: thousand persons)

Year		1983	1986	1988	1991	2000	2001	2005
Government Policy	NLDP 2nd 1)	9204	9,200	-	9,600	-	9,900	-
	NCRDBP 2)		9,500	-	9,800	-	10,000	-
Population Projection	Arithmetic Growth formulas		10,078	10,648	11,502	14,065	14,349	15,488
	Logarithmic Growth formulas		9,924	10,386	11,041	12,781	12,957	13,630
	Logistic Curve Formulas		10,150	10,567	11,113	12,246	12,332	12,619
	Exponential Growth for annual Population increase rate		9,910	10,327	10,880	12,078	12,176	12,512
Land capacity for Inhabitants			11,301 - 12,037					
Han River Basin Environmental Master Plan (Draft Report)			9,780	-	10,800	-	12,130	-

Note: 1) NLDP 2nd: Second National Land Development Plan
2) NCRDBP: National Capital Region Development Basic Plan

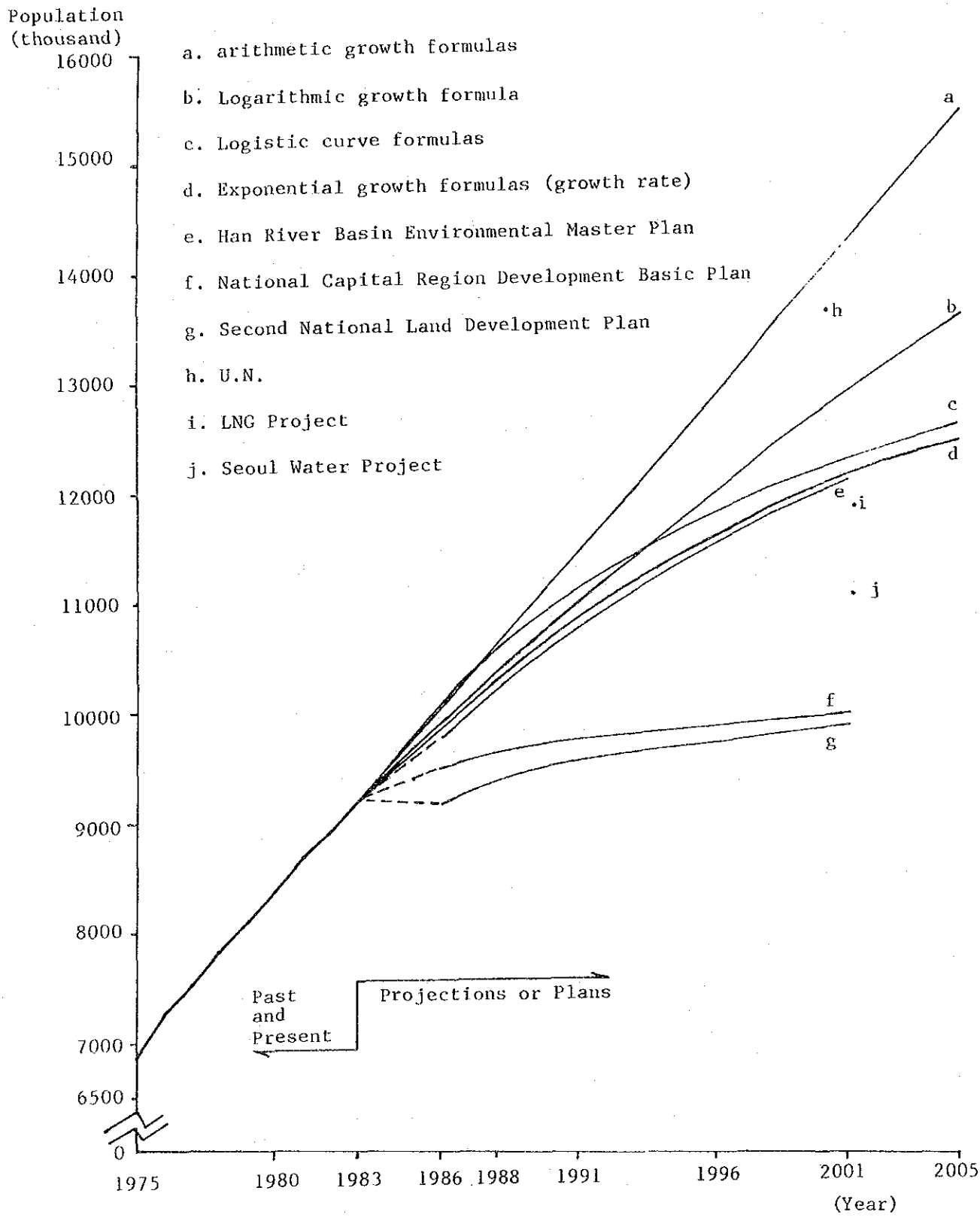


Fig. II-13 Future Population in Seoul City

Though the population increase rate has shown a declining tendency since 1976, the absolute annual increase was between 250 thousand and 300 thousand. It is considered that the sudden decline of the population increase is not likely to occur. The natural growth alone was 150 thousand persons in 1981 and 1982, and it shows an increasing tendency as can be witnessed in Fig. II-9. Therefore in this study, the population planned by the government is considered only as an indicative figure.

From the studies on the existing population forecasts, and based on an assumption that the government's population control policy will be promoted continuously, we conclude that the future population in Seoul City will be 12.2 million in 2001 and 12.5 million in 2005 (Table II-27). The estimation is based on the figures projected by the method of exponential growth formulas using the annual increase rate which reflects the declining tendency of population increase due to the population control by the government.

Table II-27 Estimated Future Populations for this Study

(Unit: thousand persons)

Year	1983	1986	1988	1991	1996	2001	2005
Population	9,204	9,900	10,300	10,900	11,600	12,200	12,500

Populations by zone are estimated with consideration of the land capacity and other conditions. The results are shown in Table II-28 , II-29 and Fig. II-14 .

The forecast populations go beyond the land capacity estimated under the various conditions. Thus, it will be necessary either to alter the land use regulation of the development restriction area, or to remove the existing facilities from the urban area to the suburbs to substitute them by residential buildings. Nevertheless, as Seoul City will doubtlessly become more overpopulated, a mighty government's policy to control the population concentration is drastically needed.

Table II-28 Estimated Future Population in 2005 by Zone

(Unit: thousand person)

Classification / Zone and Gu	Present Population (A)	Population Increase in Future Developing Area[1] (B)	Population Increase in Converted Areas from GBA[2] (C)	(A)+(B)+(C)	Estimated Future Population in 2005
Jongro	277-291	8-10	-	285-301	300
Jung	225-236	1	-	226-237	240
Zone I Total	502-527	9-11	-	511-538	540
Seongdong	737-774	95-108	-	832-882	880
Dongdaemun	914-960	58-66	30	1002-1056	1060
Seongbug	589-618	31-36	-	620-654	650
Dobong	813-854	371-433	30	1214-1317	1320
Zone II Total	3053-3206	555-643	60	3668-3909	3910
Yongsan	335-352	5	-	340-357	360
Eunpyeong	422-443	19-22	-	441-465	470
Seodaemun	423-444	16-18	-	439-462	460
Mapo	439-461	72-82	-	511-543	540
Zone III Total	1619-1700	112-127	-	1731-1827	1830
Ganseo	635-667	412-460	60	1107-1187	1190
Guro	630-661	61-69	-	691-730	730
Yeongdeungpo	446-468	29-33	-	475-501	500
Dongjag	400-420	10-12	-	410-432	430
Gwanak	540-567	14-16	-	554-583	580
Zone IV Total	2651-2783	526-590	60	3237-3433	3430
Gangnam	652-685	529-588	120	1301-1393	1390
Gangdong	727-763	366-414	220	1313-1397	1400
Zone V Total	1379-1448	895-1002	340	2614-2790	2790
Total	9204-9664	2097-2373	460	11761-12497	12500

Estimated by the study team

Note: 1) Including the planned populations in the special area development projects

2) The conversion of land use in future from the Green Belt Area to developing areas (about 1530 hectares) was considered. The percentage of these areas to the total Green Belt Area in Seoul City planning Area is about 6(%).

Table II-29 Estimated Future Population by Zone and Gu

(Unit: thousand person)

Gu \ Year	1983	1988	1991	1996	2001	2005
Jongro	277	280	290	290	300	300
Jung	225	230	230	240	240	240
Zone I Total	502	510	520	530	540	540
Seongdong	737	790	810	850	870	880
Dongdaemun	914	960	990	1,020	1,050	1,060
Seongbug	589	610	620	630	640	650
Dobong	813	980	1,070	1,180	1,270	1,320
Zone II Total	3,053	3,340	3,490	3,680	3,830	3,910
Yongsan	335	340	350	350	360	360
Eunpyeong	422	440	450	460	460	470
Seodaemun	423	440	440	450	460	460
Mapo	439	470	490	510	530	540
Zone III Total	1,619	1,690	1,730	1,770	1,810	1,830
Ganseo	635	820	920	1,040	1,140	1,190
Guro	630	660	680	700	720	730
Yeongdeungpo	446	470	470	490	490	500
Dongjag	400	410	420	420	430	430
Gwanak	540	550	560	570	580	580
Zone IV Total	2,651	2,910	3,050	3,220	3,360	3,430
Gangnam	652	900	1,030	1,190	1,320	1,390
Gangdong	727	950	1,080	1,210	1,340	1,400
Zone V Total	1,379	1,850	2,110	2,400	2,660	2,790
Total	9,204	10,300	10,900	11,600	12,200	12,500

Estimated by the study team

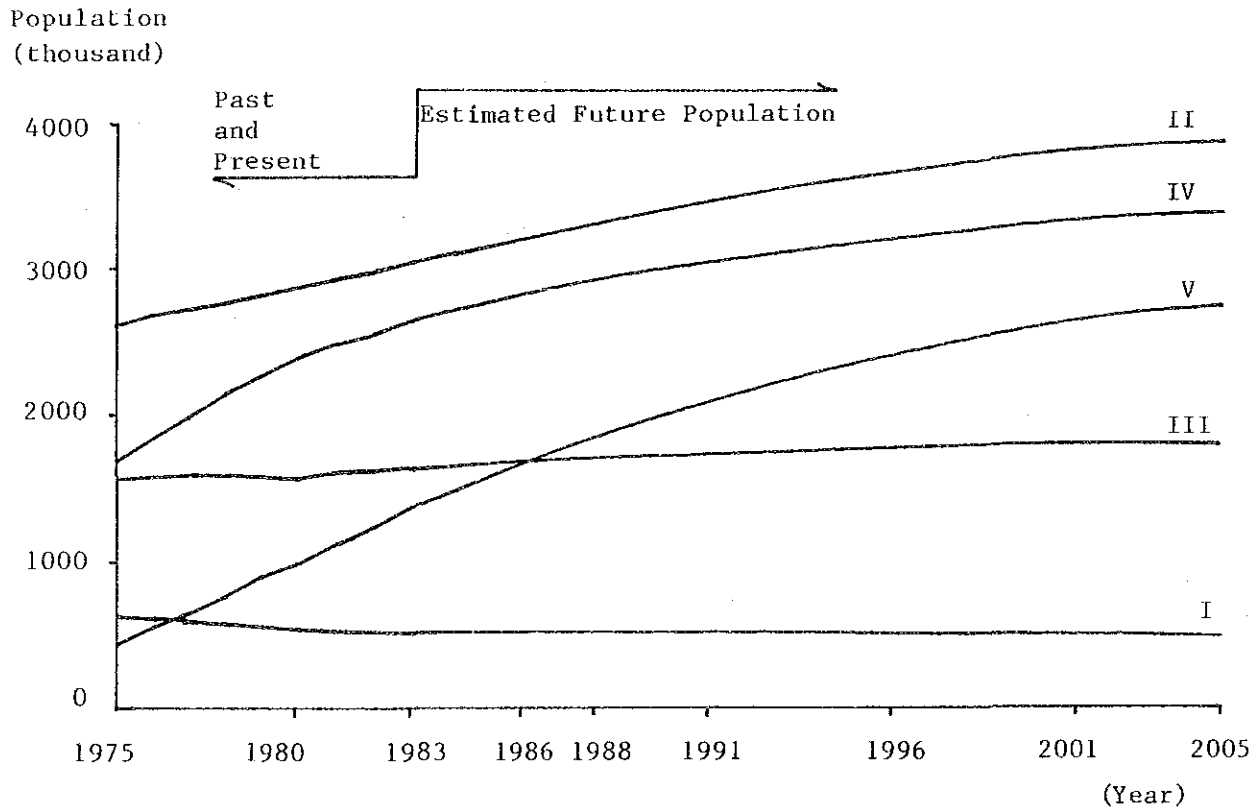


Fig. II-14 Estimated Future Population by Zone

APPENDIX III

BASIC FIELD SURVEY

APPENDIX III BASIC FIELD SURVEY

1. SURVEY DESCRIPTION

1-1 Scope of Survey

The objectives of the basic field survey are to evaluate and supplement existing data and identify the problems of the present solid waste management system in Seoul City. The results of the survey will be used as basic information to plan the optimum master plan and short term improvement project. The survey is divided into five surveys as listed below.

1. Waste generation mechanism survey
2. Collection/transportation system survey
3. Final disposal system survey
4. Recoverables market survey
5. Leachate quality survey

1-2 Survey Schedule

Four of the surveys, excluding the recoverables market survey, were carried out three times to determine seasonal fluctuations for summer, autumn and winter. The recoverables market survey was performed during the first and second periods of the other surveys. The survey periods are shown below.

First Survey : July - September, 1984

Second Survey: November - December, 1984

Third Survey : January - March, 1985

The waste generation mechanism and leachate quality surveys include samplings and analyses.

2. WASTE GENERATION MECHANISM SURVEY

2-1 Objectives

The entire Seoul City was divided into five zones as shown in Table 2-1. Fifteen sampling areas were selected in accordance with differences in housing types and use zoning. In addition, one sample from each zone was collected at Nanjido landfill site for five more samples. This total of 20 samples was analyzed to determine the characteristics of the various housing types and use zoning, as well as the peculiarities of the five zones. This characterization, if any, is the main objective of this survey.

Table 2-1 Gu Distribution into Zones

Zone Number	Gu-Name
I	Jongro-Gu, Jung-Gu
II	Seongdong-Gu, Dongdaemun-Gu, Seongbug-Gu, Dobong-Gu
III	Yongsan-Gu, Mapo-Gu, Seodaemun-Gu, Eunpyeong-Gu
IV	Ganseo-Gu, Guro-Gu, Yeogdeungpo-Gu, Dongjag-Gu, Gwanak-Gu
V	Gangnam-Gu, Gangdong-Gu

2-2 Survey Method

2-2-1 Site Selection

Based upon a city planning map of Seoul City, use zonings were color differentiated and combining results from interviews, representative sampling points were selected. These were then explained to chieves of the relevant Gu Cleansing Sections and received their consent. The selected sampling points are listed in Table 2-2.

Table 2-2 Selected Sampling Sites

Category	1st Survey	2nd Survey	3nd Survey
1.High Level Independent Residence	.Yeongsan-Gu Itaeweon-Dong .Gangnam-Gu Yeoksam-Dong	.Yeongsan-Gu Itaeweon-Dong .Gangnam-Gu Yeoksam-Dong	.Yeongsan-Gu Itaeweon-Dong .Gangnam-Gu Yeoksam-Dong
2.Medium Level Independent Residence	.Seongdong-Gu Hwayang-Dong .Mapo-Gu Seogyo-Dong	.Seongdong-Gu Hwayang-Dong .Mapo-Gu Seogyo-Dong	.Seongdong-Gu Hwayang-Dong .Mapo-Gu Seogyo-Dong
3.Low Level Independent Residence	.Seongdong-Gu Haengdang-Dong .Seodaemun-Gu Bugahyeon-Dong	.Seongdong-Gu Haengdang-Dong .Seodaemun-Gu Bugahyeon-Dong	.Seongdong-Gu Haengdang-Dong .Seodaemun-Gu Bugahyeon-Dong
4.Central Heated Apartment	.Yeongdeungpo-Gu Yeoido-Dong .Gangnam-Gu Abgujeong-Dong	.Yeongdeungpo-Gu Yeoido-Dong (2) .Gangnam-Gu Abgujeong-Dong(2)	.Yeongdeungpo-Gu Yeoido-Dong(2) .Gangnam-Gu Abguijeong-Dong(2)
5.Individual Heated Apartment	.Jongro-Gu Changsin-Dong .Gangdong-Gu Sincheong-Dong	.Jongro-Gu Changsin-Dong .Gangdong-Gu Sincheong-Dong	.Jongro-Gu Changsin-Dong .Gangdong-Gu Sincheong-Dong
6.Commercial Area	.Jung-Gu Myeong-Dong	.Jung-gu Myeong-Dong .Yongsan-Gu Itaeweon-Dong	.Jung-Gu Myeong-Dong .Yongsan-Gu Itaeweon-Dong
7.Factory	.Guro-Gu Guro-Dong		
8.Business Facility	.Jung-Gu Hilton Hotel		
9.Public Facility	.Jung-Gu Seoul Stadium		
10.Market	.Dongdaemun-Gu	.Yeongdeungpo-Gu	.Yeongdeungpo-Gu

The first survey revealed that factories, hotels and athletic facilities were distinct in that many of them self-disposed of their waste. Therefore, from the second survey, these categories were replaced with additional samplings of two extra central heated apartments and one more shopping center.

2-2-2 Sampling Method

(1) Independent Residences

First, the collection route of hand carts were traced. Then, the served houses were surveyed for number of households and population. For each site, the amount of waste collected by one hand cart was measured and a sample was taken.

(2) Apartments

From each sampling point, the total amount of waste inside a dust chute was measured and a sample was collected. The number of households and population using the sampled dust chute were surveyed.

(3) Other Sites

From the waste storage areas of the selected sites, samples of 300 to 500 kg were collected.

(4) Sampling at Nanjido

Refuse trucks from each Gu as indicated in Table 2-3 were requested to dump their truckload of waste according to Zone at designated locations at Nanjido. Each of the five waste piles was mixed and quartered with a bulldozer to make about 300 kg samples.

Table 2-3

Number of Refuse Trucks for Nanjido Sampling

Zone	Gu-Name	Number of Trucks
I	Jongro-Gu	2
	Jung-Gu	2
II	Seongdong-Gu	2
	Dongdaemun-Gu	2
	Seongbug-Gu	1
	Dobong-Gu	1*
III	Yongsan-Gu	2
	Mapo-Gu	1
	Seodaemun-Gu	1
	Eunpyeong-Gu	1
IV	Gangseo-Gu	1
	Guro-Gu	2
	Yeongdeungpo-Gu	2
	Dongjag-Gu	1
	Gwanak-Gu	1
V	Gangnam-Gu	2
	Gangdong-Gu	2

* Not sampled in summer.

(5) Samples for Analysis

At each of the sampling sites, the initial waste sample was transferred onto a plastic sheet. Here, quartering was carried out to yield an approximately 10 kg sample. This sample was placed in a lidded container and taken to the laboratory for analysis. For the third survey, due to the probability that a high percentage of briquet ash would be found, the sample for analysis was increased to 20 kg.

2-2-3 Analysis Method

The collected samples were analyzed for physical and chemical properties following the flow depicted in Fig. 2-1. The methods used for analyzing chemical elements are listed in Table 2-4.

Table 2-4 Elemental Analysis Methods

Element	Quantitative Analysis	Instrument
Carbon	Gravimetric analysis	Elemental Analyzer
Hydrogen	Gravimetric analysis	
Nitrogen	Volumetric analysis (Neutralization)	
Sulfur	Volumetric analysis (Neutralization)	Elemental Analyzer
Chlorine	Volumetric analysis (Volhard method)	
Oxygen	Ignition loss - (Carbon + Hydrogen + Nitrogen + Sulfur + Chlorine)	

2-3 Results

The results of the generation rate survey are presented in Table 2-5. The result of analyses on physical and chemical properties are shown in Table 2-6 through Table 2-12.

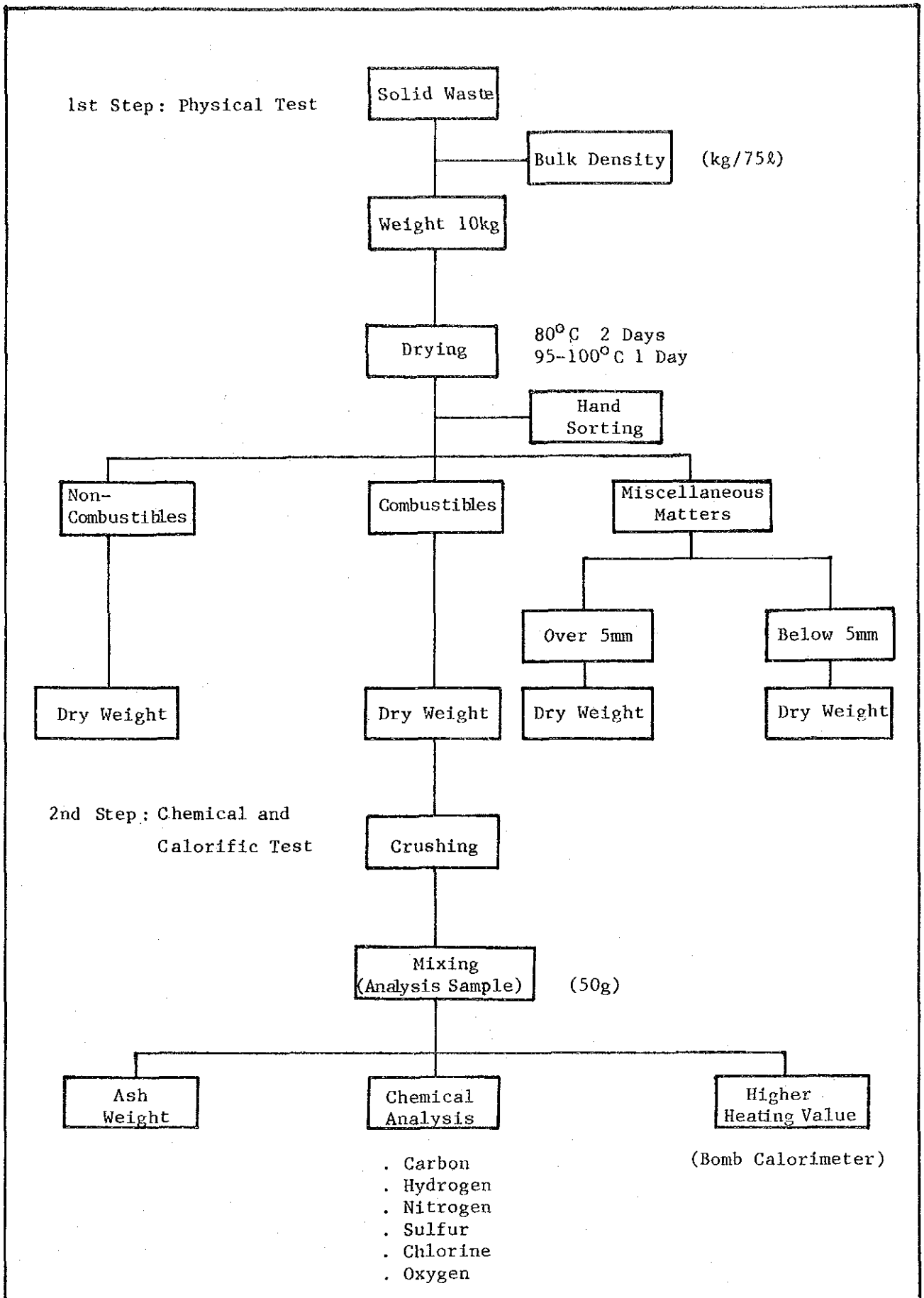


Fig. 2-1 Flow Diagram for Characteristic Analysis

Table 2-5 Surveyed Per Capita Rate for Residences

Sampling Points		Collected Waste (kg)	Householes	Population	Per Capita Rate (kg/cap/d)
High Level Independent Residence					
Itaeweon Dong	Jul. 27	188/1 Day	23	127	1.480
	Nov. 26	422/2 Days	17	92	2.293
	Feb. 4	299/3 Days	18	76	1.311
Yeoksan Dong	Jul. 28	281/2 Days	57	274	0.512
	Nov. 24	509/2 Days	32	125	2.036
	Feb. 2	415/3 Days	18	67	2.065
Medium Level Independent Residence					
Hwayang Dong	Jul. 25	922/2 Days	147	491	1.010
	Nov. 21	642/2 Days	46	181	1.773
	Jan. 30	692/3 Days	32	109	2.116
Seogyo Dong	Jul. 27	276/1 Day	41	179	1.542
	Nov. 23	235/1.5 Days	18	83	1.888
	Feb. 1	549/2 Days	27	103	2.665
Low Level Independent Residence					
Haendang Dong	Jul. 25	225/1 Day	66	237	0.949
	Nov. 21	403/1 Day	53	236	1.708
	Jan. 30	197/2 Days	25	104	0.947
Bugahyeon Dong	Jul. 27	312/2 Days	67	254	0.619
	Nov. 23	-	-	-	-
	Feb. 1	396/7 Days	12	49	1.155
Average in Independent Residence		-	-	-	(1.533)
	Summer				1.019
	Autumn				1.939
	Winter				1.713
Central Heated Apartment					
Yeoido Dong	Jul. 31	191/2 Days	28	137	0.697
	Nov. 27	119/2 Days	24	106	0.561
	Nov. 27	118/2 Days	24	112	0.527
	Feb. 5	141/1.5 Days	24	101	0.931
	Feb. 5	91/1.5 Days	24	106	0.572
Abgujeong Dong	Jul. 28	255/2 Days	26	134	0.951
	Nov. 24	47/1 Day	12	54	0.870
	Nov. 24	76/1 Day	12	48	1.583
	Feb. 2	119/6 Days	12	53	0.374
	Feb. 2	124/6 Days	12	57	0.363
Average in Central heated Apartment		-	-	-	(0.743)
	Summer				0.784
	Autumn				0.885
	Winter				0.560
Individual Heated Apartment					
Changsin 3 Dong	Jul. 30	493/2 Days	28	141	1.748
	Nov. 26	625/2 Days	29	125	2.500
	Feb. 4	587/3 Days	30	133	1.471
Sinchon Dong	Jul. 28	395/3 Days	16	73	1.639
	Nov. 21	316/3 Days	13	49	2.150
	Jan. 30	246/3 Days	6	25	3.280
Average in Individual Heated Apartment		-	-	-	(2.131)
	Summer				1.694
	Autumn				2.325
	Winter				2.376
Average in Residences					(1.469)
	Summer				1.166
	Autumn				1.716
	Winter				1.549

Table 2-6 Physical and Chemical Composition of Waste

(Dry Basis wt %)

Classification	High Level Independent Residences					
Sampling Point	(Itaeweon Dong)			(Yeoksam Dong)		
Sampling Date	Jul. 27	Nov. 26	Feb. 4	Jul. 28	Nov. 24	Feb. 2
(Combustibles)						
Paper	21.47	26.22	51.66	19.10	5.44	10.07
Textiles	6.82	1.04	0.05	6.89	0.15	
Garbage	6.85	14.17	12.47	23.66	5.73	4.98
Woods	18.48	8.93	4.37	6.12	0.67	0.12
Plastics	4.24	3.80	14.69	7.27	1.86	1.80
Leathers and Rubbers	10.49	0.04	-	1.27	0.03	0.01
Others	0.60	0.52	1.50	1.38	1.26	1.10
Sub Total	68.95	54.72	84.74	65.69	15.14	18.08
(Noncombustibles)						
Ferrous Metals	5.45	1.69	0.46	1.00	0.67	1.62
Non-Ferrous Metals	1.94	0.37	2.65	0.43	0.08	-
Glass	15.17	9.25	5.69	21.50	7.02	-
Bones, Stones & Ceramics	6.84	18.79	0.05	9.95	1.70	-
Briquet Ash	-	14.72	5.21	-	74.29	79.34
Others	1.65	0.46	1.20	1.43	1.10	0.96
Sub Total	31.05	45.28	15.26	34.31	84.86	81.92
						(wet Basis)
Bulk Density (kg/ℓ)	0.190	0.227	0.127	0.363	0.343	0.333
Three major components						
(wt %) Moisture	42.39	49.18	46.85	64.70	26.44	22.45
Ash	24.32	28.17	12.43	16.47	64.26	65.28
Combustible	33.29	22.65	40.72	18.83	9.30	12.27
Total	100	100	100	100	100	100
Elemental composition						
(wt %) C	17.56	11.31	21.53	9.77	5.09	6.38
H	2.49	1.49	2.81	1.51	0.66	0.87
N	1.16	0.30	0.26	0.61	0.18	0.11
O	11.60	9.29	15.71	6.61	3.24	4.80
S	0.12	0.04	0.07	0.06	0.02	0.03
Cl	0.36	0.22	0.34	0.27	0.11	0.08
Total	33.29	22.65	40.72	18.83	9.30	12.27
Lower Heating Value*(kcal/kg)	1440	820	1770	620	360	500

* Actual measurement

Table 2-7 Physical and Chemical Composition of Waste

(Dry Basis wt %)

Classification	Medium Level Independent Residences					
Sampling Point	(Hwayang Dong)			(Seogyo Dong)		
Sampling Date	Jul. 25	Nov. 21	Jan. 30	Jul. 27	Nov. 23	Feb. 1
(Combustibles)						
Paper	12.42	1.50	3.10	25.83	6.06	1.87
Textiles	6.15	0.15	0.50	5.35	4.34	0.36
Garbage	8.08	1.05	7.26	8.40	5.54	0.67
Woods	4.13	0.38	0.64	4.30	3.80	0.07
Plastics	5.11	1.56	2.97	2.64	4.96	0.66
Leathers and Rubbers	0.14	-	-	-	3.82	-
Others	1.63	2.52	1.05	2.07	1.29	1.83
Sub Total	37.66	7.16	15.52	48.59	29.81	5.46
(Noncombustibles)						
Ferrous Metals	2.41	0.12	0.08	6.24	0.37	0.45
Non-Ferrous Metals	0.07	0.07	0.04	0.05	0.70	-
Glass	19.24	0.59	4.20	4.06	3.67	-
Bones, Stones & Ceramics	4.23	-	0.75	2.13	6.95	0.15
Briquet Ash	33.37	89.85	78.49	37.07	57.38	92.33
Others	3.02	2.21	0.92	1.86	1.12	1.61
Sub Total	62.34	92.81	84.48	51.41	70.19	94.54
						(wet Basis)
Bulk Density (kg/ℓ)	0.370	0.437	0.340	0.210	0.323	0.487
Three major components						
(wt %) Moisture	44.21	17.55	28.33	43.58	27.96	5.48
Ash	38.14	77.12	62.12	33.97	53.55	90.20
Combustible	17.65	5.33	9.55	22.45	18.49	4.32
Total	100	100	100	100	100	100
Elemental composition						
(wt %) C	8.99	3.12	5.15	11.08	10.08	2.17
H	1.22	0.40	0.64	1.57	1.35	0.30
N	0.47	0.03	0.19	0.81	0.50	0.12
O	6.71	1.72	3.42	8.78	6.13	1.69
S	0.04	0.01	0.02	0.04	0.07	0.01
Cl	0.22	0.05	0.13	0.17	0.36	0.03
Total	17.65	5.33	9.55	22.45	18.49	4.32
Lower Heating Value*(kcal/kg)	610	220	370	820	880	180

* Actual measurement

Table 2-8 Physical and Chemical Composition of Waste

(Dry Basis wt %)

Classification	Low Level Independent Residences					
Sampling Point	(Haengdang Dong)			(Bugahyeon Dong)		
Sampling Date	Jul. 25	Nov. 21	Jan. 30	Jul. 27	Nov. 28	Feb. 1
(Combustibles)						
Paper	12.93	5.93	1.69	17.40	2.22	1.14
Textiles	4.28	2.17	0.03	5.04	0.81	0.23
Garbage	3.78	2.14	3.86	6.32	3.17	3.50
Woods	1.67	1.46	1.17	8.21	0.23	0.98
Plastics	6.27	3.01	3.12	9.75	1.38	1.61
Leathers and Rubbers	0.10	1.47	-	0.18	0.82	-
Others	1.85	1.52	1.25	0.69	1.92	1.36
Sub Total	30.88	17.70	11.12	47.59	10.55	8.82
(Noncombustibles)						
Ferrous Metals	1.95	0.45	0.01	28.25	0.78	0.11
Non-Ferrous Metals	0.82	0.73	0.03	0.49	0.15	0.01
Glass	5.90	1.64	3.00	12.71	0.73	0.17
Bones, Stones & Ceramics	5.85	7.33	0.02	3.31	0.01	-
Briquet Ash	51.24	70.82	84.53	6.03	86.09	89.70
Others	3.36	1.33	1.29	1.62	1.69	1.19
Sub Total	69.12	82.30	88.88	52.41	89.45	91.18
					(wet Basis)	
Bulk Density (kg/l)	0.303	0.290	0.447	0.283	0.450	0.427
Three major components						
(wt %) Moisture	34.54	28.60	8.66	49.51	13.96	15.21
Ash	48.04	60.01	83.13	30.52	78.40	79.20
Combustible	17.42	11.39	8.21	19.97	7.64	5.59
Total	100	100	100	100	100	100
Elemental composition						
(wt %) C	9.15	6.38	4.18	9.42	4.00	2.90
H	1.34	0.80	0.49	1.33	0.52	0.40
N	0.50	0.12	0.07	0.54	0.09	0.07
O	6.21	3.55	3.23	7.37	2.92	2.11
S	0.03	0.02	0.01	0.05	0.03	0.01
Cl	0.19	0.52	0.23	1.26	0.08	0.10
Total	17.42	11.39	8.21	19.97	7.64	5.59
Lower Heating Value *(kcal/kg)	740	470	370	640	300	200

* Actual measurement

Table 2-9 Physical and Chemical Composition of Waste

(Dry Basis wt %)

Classification	Central Heated Apartments									
Sampling Point	(Yeiodo Dong) (Sujeong Apt.)	(Hanyang Apt.)		(Daegyo Apt.)		(Abgahyeon Dong) (Hyundai Apt.)				
Sampling Date	Jul. 31	Nov. 27	Nov. 27	Feb. 5	Feb. 5	Jul. 28	Nov. 24	Nov. 24	Feb. 2	Feb. 2
(Combustibles)										
Paper	19.90	41.50	42.06	30.94	34.56	31.10	24.60	34.66	17.44	25.61
Tetiles	5.52	0.11	0.16	0.59	0.69	3.99	3.16	3.53	-	5.57
Garbage	19.85	26.42	30.01	24.80	24.79	25.09	37.40	31.75	35.66	38.42
Woods	1.58	1.26	0.62	2.85	0.69	2.13	0.77	4.86	12.67	3.16
Plastics	16.45	9.29	11.81	12.92	17.81	14.05	20.78	11.98	9.32	12.13
Leathers and Rubbers	4.31	-	-	0.07	0.53	0.13	-	1.05	4.44	0.07
Others	1.03	-	-	3.67	1.84	1.92	-	-	3.46	0.77
Sub Total	68.64	78.58	84.66	75.84	80.91	78.41	86.71	87.83	82.99	85.73
(Noncombustibles)										
Ferrous Metals	8.27	5.36	10.26	9.71	3.25	5.57	2.86	1.67	3.99	3.64
Non-Ferrous Metals	0.61	0.76	1.49	0.13	2.90	0.65	0.52	1.07	1.40	0.07
Glass	16.19	15.00	0.43	9.02	11.05	6.22	3.02	9.01	2.15	1.71
Bones. Stones & Ceramics	5.24	0.30	3.16	5.30	1.89	7.39	6.89	0.42	9.47	8.85
Briquet Ash	-	-	-	-	-	-	-	-	-	-
Others	1.05	-	-	-	-	1.76	-	-	-	-
Sub Total	31.36	21.42	15.34	24.16	19.09	21.59	13.29	12.17	17.01	14.27
									(wet Basis)	
Bulk Density (kg/ℓ)	0.220	0.190	0.222	0.166	0.147	0.377	0.193	0.210	0.193	0.200
Three Major Components (wt %) Moisture	64.23	55.27	64.35	55.96	50.58	71.42	60.63	63.69	48.02	53.72
Ash	14.70	15.98	10.42	13.71	13.35	10.00	11.07	9.11	12.99	9.66
Combustible	21.07	28.75	25.23	30.33	36.07	18.58	28.30	27.20	38.99	36.62
Total	100	100	100	100	100	100	100	100	100	100
Elemental Composition (wt %) C	11.90	15.15	13.22	16.10	19.79	10.13	14.99	14.64	20.83	18.37
H	1.86	2.09	1.77	2.16	2.71	1.55	2.05	1.97	2.85	2.57
N	0.60	0.40	0.39	0.36	0.44	0.61	0.36	0.45	0.47	0.49
O	5.71	10.56	9.29	11.34	12.28	5.79	10.40	8.90	14.26	14.43
S	0.04	0.05	0.06	0.06	0.06	0.05	0.05	0.05	0.10	0.06
Cl	0.96	0.50	0.50	0.31	0.79	0.45	0.45	1.19	0.48	0.70
Total	21.07	28.75	25.23	30.33	36.07	18.58	28.30	27.20	38.99	36.62
Lower Heating Value* (kcal/kg)	890	1140	910	1280	1730	630	1160	1070	1780	1490

* Actual measurement

Table 2-10 Physical and Chemical Composition of Waste

(Dry Basis wt %)

Classification	Individual Heated Apartments					
Sampling Point	(Changsin 3 Dong) (Changsin Apt.)			(Sinchon Dong) (Jamsil City Apt.)		
Sampling Date	Jul. 30	Nov. 26	Feb. 4	Jul. 28	Nov. 21	Jan. 30
(Combustibles)						
Paper	12.07	2.32	2.05	23.40	3.42	1.80
Textiles	3.35	0.26	0.02	0.67	1.49	0.11
Garbage	7.00	8.46	6.44	6.71	1.97	1.18
Woods	15.62	0.28	0.94	7.30	0.38	0.19
Plastics	7.17	0.79	0.80	7.55	1.04	1.43
Leathers and Rubbers	7.95	0.06	0.01	0.19	-	-
Others	2.07	1.33	1.59	1.34	2.23	1.85
Sub Total	55.23	13.50	11.85	47.16	10.53	6.56
(Noncombustibles)						
Ferrous Metals	1.05	0.01	0.05	0.76	0.39	0.04
Non-Ferrous Metals	-	0.02	0.03	0.30	-	0.01
Glass	2.97	1.66	1.79	5.83	4.50	1.49
Bones, Stones & Ceramics	12.71	1.97	3.30	2.42	0.06	0.07
Briquet Ash	26.06	81.67	81.58	41.93	82.56	90.20
Others	1.98	1.17	1.40	1.60	1.96	1.63
Sub Total	44.77	86.50	88.15	52.84	89.47	93.44
					(wet Basis)	
Bulk Density (kg/ℓ)	0.497	0.397	0.333	0.297	0.423	0.437
Three major components						
(wt %) Moisture	47.28	18.79	17.20	54.35	14.07	10.73
Ash	30.47	72.28	75.13	28.15	77.96	84.13
Combustible	22.25	8.93	7.67	17.50	7.97	5.14
Total	100	100	100	100	100	100
Elemental composition (wt %) C	12.40	4.50	3.78	8.80	4.29	2.82
H	1.70	0.53	0.46	1.23	0.56	0.38
N	0.57	0.12	0.08	0.43	0.14	0.11
O	6.17	3.69	3.28	6.45	2.90	1.73
S	0.18	0.02	0.02	0.04	0.02	0.01
Cl	1.23	0.07	0.05	0.55	0.06	0.09
Total	22.25	8.93	7.67	17.50	7.97	5.14
Lower Heating Value *(kcal/kg)	970	320	270	550	350	260

* Actual measurement

Table 2-11 Physical and Chemical Composition of Waste

(Dry Basis wt %)

Classification	Commercial Area					Factory	Business Facility	Public Facility	Market		
Sampling Point	(Myeong Dong)			(Itaeweon Dong)		(Guro Dong)	(Hilton Hotel)	(Seoul Play Ground)	(Dongbu Chongkwa Sijang)	(Yeongdeungpo Sijang)	
Sampling Date	Jul. 30	Nov. 26	Feb. 4	Nov. 26	Feb. 4	Jul. 31	Jul. 30	Jul. 30	Jul. 25	Nov. 23	Feb.1
(Combustibles)											
Paper	50.66	32.90	38.57	25.30	34.24	2.61	41.95	28.28	2.61	4.99	2.48
Textiles	8.98	0.71	11.73	2.92	0.76	2.62	11.17	-	-	2.04	-
Garbage	4.30	15.46	4.32	5.49	11.93	0.13	1.08	4.10	90.83	38.07	33.11
Woods	1.35	4.39	2.95	1.66	8.76	45.18	1.76	2.88	2.98	3.26	2.85
Plastics	5.05	9.90	3.94	9.98	9.40	13.83	11.92	11.87	0.30	3.65	5.61
Leathers and Rubbers	3.53	1.98	-	2.36	-	-	0.07	-	-	-	-
Others	1.09	0.20	1.86	0.63	4.96	1.69	0.41	0.83	3.10	0.37	0.81
Sub Total	74.96	65.54	63.37	48.34	70.05	66.06	68.36	47.96	99.82	52.38	44.86
(Noncombustibles)											
Ferrous Metals	14.57	1.40	3.57	2.15	0.88	18.99	8.97	36.61	-	0.95	1.83
Non-Ferrous Metals	0.26	0.36	1.41	0.58	0.21	0.17	2.83	3.40	-	-	-
Glass	8.63	21.01	30.11	20.74	14.55	3.47	19.18	8.04	-	5.48	-
Bones, Stones & Ceramics	-	5.33	0.61	0.48	-	6.39	0.34	1.16	0.18	0.12	-
Briquet Ash	-	6.18	-	27.15	9.74	0.94	-	-	-	40.75	52.72
Others	1.58	0.18	0.93	0.56	4.57	3.98	0.32	2.83	-	0.32	0.59
Sub Total	25.04	34.46	36.63	51.66	29.95	33.94	31.64	52.04	0.18	47.62	55.14
										(wet Basis)	
Bulk Density (kg/ℓ)	0.170	0.250	0.095	0.103	0.190	0.433	0.086	0.076	0.360	0.197	0.290
Three Major Components (wt %) Moisture	36.62	54.01	22.42	24.52	47.68	28.06	28.82	22.93	85.98	60.86	46.03
Ash	21.43	21.34	33.33	44.40	19.77	30.36	25.88	43.65	6.31	25.04	39.03
Combustible	41.95	24.65	44.25	31.08	32.55	41.58	45.30	33.42	7.71	14.10	14.94
Total	100	100	100	100	100	100	100	100	100	100	100
Elemental Composition (wt %) C	21.05	12.79	22.08	17.19	16.79	23.14	23.21	18.34	3.68	7.53	9.13
H	3.21	1.75	2.87	2.31	2.18	2.78	3.63	2.67	0.57	0.96	1.16
N	1.21	0.37	0.72	0.26	0.17	1.45	0.96	0.79	0.46	0.35	0.27
O	16.13	8.97	18.30	10.98	12.95	13.06	17.16	11.30	2.81	5.01	4.08
S	0.10	0.05	0.11	0.07	0.06	0.06	0.07	0.06	0.06	0.06	0.07
Cl	0.25	0.72	0.17	0.27	0.40	1.09	0.27	0.26	0.13	0.19	0.23
Total	41.95	24.65	44.25	31.08	32.55	41.58	45.30	33.42	7.71	14.10	14.94
Lower Heating Value *(kcal/kg)	1980	1000	2000	1630	1350	2100	2310	1750	-	390	590

* Actual measurement

Table 2-12 Physical and Chemical Composition of Waste

(Dry Basis wt %)

Sampling at Nanjido Final Disposal Site															
Zone	(Zone I)			(Zone II)			(Zone III)			(Zone IV)			(Zone V)		
Sampling Date	Jul.26	Nov.22	Jan.31	Jul.26	Nov.22	Jan.31	Jul.26	Nov.22	Jan.31	Jul.26	Nov.22	Jan.31	Jul.26	Nov.22	Jan.31
(Combustibles)															
Paper	12.22	1.23	3.61	10.70	1.26	2.32	17.14	3.99	2.67	19.58	4.04	4.29	21.23	7.05	13.78
Textiles	1.22	1.09	1.40	2.22	0.46	1.26	6.23	0.66	2.27	5.52	1.10	0.20	4.03	3.34	1.04
Garbage	16.25	2.79	3.48	12.13	1.29	1.26	6.22	3.49	1.04	11.92	4.39	2.13	4.95	5.83	2.88
Woods	9.96	0.52	0.63	7.12	0.44	0.30	10.39	1.11	0.70	2.74	0.66	0.16	7.01	0.95	0.61
Plastics	5.35	1.37	2.15	6.78	2.42	1.15	4.68	1.68	1.67	8.77	1.83	0.85	4.31	3.15	3.31
Leathers and Rubbers	1.24	-	0.23	8.75	0.08	0.03	0.37	0.46	1.12	4.09	-	0.38	3.70	0.10	4.00
Others	6.09	3.21	1.91	5.43	3.53	2.25	5.73	2.82	1.80	2.70	1.98	1.80	2.75	1.66	1.18
Sub Total	52.33	10.21	13.41	53.13	9.48	8.57	50.76	14.21	11.27	55.32	14.00	9.81	47.98	22.08	26.80
(Noncombustibles)															
Ferrous Metals	0.58	0.16	1.05	10.04	0.19	0.43	2.43	0.39	0.71	1.38	0.04	0.46	3.91	0.50	4.70
Non-Ferrous Metals	0.95	-	0.11	0.44	0.21	0.02	0.28	0.02	0.02	0.09	0.01	0.28	0.54	0.14	0.05
Glass	4.71	0.15	1.05	16.74	0.74	1.19	14.31	0.51	1.27	8.77	-	0.92	8.46	2.02	7.78
Bones, Stones & Ceramics	6.98	3.46	0.88	1.53	0.99	3.24	4.30	1.21	0.07	15.36	-	0.10	23.29	2.04	0.40
Briquet Ash	29.73	83.20	81.82	16.68	85.30	84.58	25.83	81.18	85.09	17.90	84.22	86.85	12.55	71.76	59.23
Others	4.72	2.82	1.68	1.44	3.09	1.97	2.09	2.48	1.57	1.18	1.73	1.58	3.27	1.46	1.04
Sub Total	47.67	89.79	86.59	46.87	90.52	91.43	49.24	85.79	88.73	44.68	86.00	90.19	52.02	77.92	73.20

(wet Basis)

Bulk Density (kg/ℓ)	0.303	0.337	0.433	0.396	0.490	0.437	0.290	0.443	0.477	0.357	0.330	0.360	0.317	0.350	0.237
Three Major Components (wt %) Moisture	57.93	25.02	21.41	47.80	25.54	16.30	50.40	24.11	14.00	54.39	22.93	13.40	50.52	29.75	23.56
Ash	25.42	68.53	69.11	31.14	68.21	77.19	26.74	66.76	77.26	25.52	67.73	79.80	30.96	57.33	58.35
Combustible	16.65	6.45	9.48	21.06	6.25	6.51	22.86	9.13	8.74	20.09	9.34	6.80	18.52	12.92	18.09
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Elemental Composition (wet %) C	8.08	3.66	5.22	11.83	3.75	3.42	12.32	4.91	4.67	10.71	5.15	3.46	9.17	6.88	9.10
H	1.15	0.48	0.70	1.70	0.51	0.46	1.66	0.59	0.61	1.54	0.61	0.47	1.31	0.93	1.26
N	0.63	0.15	0.20	0.81	0.05	0.06	0.67	0.20	0.07	0.96	0.14	0.06	0.50	0.18	0.17
O	6.47	2.07	3.29	6.26	1.74	2.49	7.85	3.22	3.15	6.45	3.23	2.66	6.61	4.57	6.30
S	0.04	0.02	0.01	0.09	0.01	0.01	0.05	0.03	0.02	0.07	0.03	0.01	0.05	0.04	0.04
Cl	0.28	0.07	0.06	0.37	0.19	0.07	0.31	0.18	0.22	0.36	0.18	0.14	0.88	0.32	1.22
Total	16.65	6.45	9.48	21.06	6.25	6.51	22.86	9.13	8.74	20.09	9.34	6.80	18.52	12.92	18.09
Lower Heating Value *(kcal/kg)	470	230	430	940	230	260	890	320	470	770	510	260	620	510	790

* Actual measurement

2-4 Considerations

2-4-1 Per Capita Generation Rate

For independent residences, the annual average per capita generation rate is 1.533 kg/cap/day. The rate is about 1.0 kg/cap/day in the summer and about 1.8 kg/cap/day in the autumn and winter.

Central heated apartments have an average of 0.743 kg/cap/day. The autumn rate of 0.885 kg/cap/day as compared to the winter rate of 0.560 kg/cap/day is higher.

The per capita rate from individual heated apartments average 2.133 kg/cap/day. This is about 1.7 kg/cap/day in the summer and 2.3 kg/cap/day in the autumn and winter.

The average rate on the total is 1.5 kg/cap/day, with 1.4 kg/cap/day for summer, 1.7 kg/cap/day for autumn and 1.5 kg/cap/day for winter. This reveals that briquet is being used as the heating source after November. Furthermore, the per capita rate for central heated apartments in the winter is low, but the average of 0.743 kg/cap/day can be considered as the generation rate for a typical family in Seoul City when briquet ash is excluded.

2-4-2 Physical Analysis

(1) Bulk Density

The average bulk densities of the samples are indicated in Table 2-13. The density for central heated apartments of 0.21 which is refuse without briquet ash is about the average. The value for individual heated aprtments of 0.397 is the highest, which is the result of a high mixture of briquet ash. The 0.370 value obtained for the Nanjido sampling is a little high, but since waste going to Nanjido becomes compressed during transportation, this can be considered as the average bulk density.

Table 2-13 Average Bulk Densities

Sample	Density (kg/ℓ)
Independent Residence	
High Level	0.263
Medium Level	0.360
Low Level	0.366
Apartment	
Central Heated	0.211
Individual Heated	0.397
Commercial Area	0.161
Nanjido Sampling	0.370

(2) Physical Composition

The physical composition of various housing types and use zonings show big differences. Central heated apartments have no briquet ash, while in contrast, individual heated apartments generate a large amount of briquet ash. High level independent residences do not generate briquet ash in the summertime but during autumn and winter, the quantity is high. Commercial areas, factories and public facilities differ in their waste composition in accordance with the location. Market waste has a high content of vegetables giving a characteristic of its own.

The results obtained from the sampling at Nanjido will be used to make comments on the waste of Seoul City in general. The present survey results are in weight percentages on dry basis and therefore, these will be converted to that on wet basis. To make adjustments in moisture content, Table 2-14 was used as reference, and the values for autumn were obtained by taking averages of the summer and winter figures. The converted values are given in Table 2-15.

Table 2-14 Composition of Waste in Summer and Winter of Seoul (1982)

Items / Component	Summer			Winter		
	Wt (%) (wet base)	Wt(%) (dry base)	Moisture Content (%)	Wt(%) (wet base)	Wt(%) (dry base)	Moisture Content (%)
Subtotal	69.17	30.06	39.13	25.90	16.18	9.74
Garbage	34.65	4.88	85.90	11.35	4.46	60.65
Paper	10.52	5.88	46.00	7.29	5.67	22.22
Plastics	4.52	3.47	23.20	2.81	2.32	17.43
Textile	1.92	1.50	21.40	0.68	0.52	23.75
Woods	3.16	2.39	24.30	0.80	0.63	21.30
Rubbers	0.55	0.54	5.50	0.36	0.34	5.50
Straw, Grass	13.85	11.60	16.00	2.61	2.24	14.00
Subtotal	30.83	26.22	4.59	74.10	64.74	9.05
Briquet Ash	16.04	12.51	21.97	70.51	61.39	12.51
Metals	1.42	1.42	0	0.68	0.68	0
Glass, Ceramics, Others.	13.37	12.29	8.05	2.91	2.67	8.06
Total	100	56.28	43.72	100	81.21	18.79

Source: Journal of Pollution Control Vol.15, No. 2, April, 1984.

Table 2-15 Physical Composition of Waste

(Wet basis wt %)

	Component \ Season / Zone	Summer (Sep.)						Autumn (Nov.)						Winter (Feb.)					
		I	II	III	IV	V	Average	I	II	III	IV	V	Average	I	II	III	IV	V	Average
Combustibles	Paper	9.82	9.89	18.27	17.73	24.21	15.98	1.44	1.51	4.57	4.55	7.71	3.96	3.82	2.52	2.91	4.64	14.74	5.73
	Textile	0.67	1.41	4.57	3.43	3.16	2.65	1.08	0.47	0.64	1.05	3.11	1.27	1.52	1.40	2.53	0.22	1.13	1.36
	Garbage	50.03	42.94	25.39	41.35	21.63	36.27	8.03	3.81	9.85	12.19	15.75	9.93	7.29	2.71	2.24	4.55	6.09	4.58
	Wood	5.71	4.70	7.90	1.77	5.70	5.16	0.52	0.45	1.09	0.63	0.89	0.72	0.66	0.32	0.76	0.17	0.63	0.51
	Plastic	3.03	4.41	3.51	5.58	3.46	3.99	1.32	2.40	1.59	1.71	2.85	1.97	2.14	1.18	1.71	0.87	3.34	1.85
	Leather & Rubber	0.57	4.62	0.22	2.12	2.41	1.99	0	0.06	0.37	0	0.08	0.10	0.20	0.03	1.01	0.34	3.52	1.02
	Others	5.29	5.42	6.60	2.64	3.39	4.67	4.93	5.57	4.25	2.94	2.39	4.02	3.15	3.81	3.05	3.03	1.96	3.00
	Sub-Total	75.12	73.39	66.46	74.62	63.96	70.71	17.32	14.27	22.36	23.07	32.76	21.97	18.78	11.97	14.21	13.82	31.41	18.05
Non-Combustibles	Ferrous Metals	0.25	5.01	1.40	0.67	2.41	1.95	0.12	0.15	0.29	0.03	0.36	0.19	0.87	0.36	0.60	0.39	3.91	7.22
	Nonferrous Metals	0.41	0.22	0.16	0.04	0.33	0.23	0	0.17	0.02	0.01	0.10	0.06	0.09	0.02	0.02	0.23	0.04	0.08
	Glass	2.22	9.13	8.96	4.67	5.67	6.13	0.12	0.63	0.41	0	1.59	0.55	0.94	1.09	1.17	0.84	7.04	2.21
	Bones, Stones & Ceramics	3.29	0.83	2.69	8.17	15.60	6.12	2.89	0.85	0.99	0	1.60	1.27	0.79	2.98	0.07	0.09	0.37	0.86
	Briquet ash	16.55	10.67	19.06	11.22	9.91	13.48	77.27	81.36	73.96	75.54	62.49	74.12	77.08	81.83	82.53	83.24	56.32	76.20
	Others	2.16	0.75	1.27	0.61	2.12	1.38	2.28	2.57	1.97	1.35	1.10	1.84	1.45	1.75	1.40	1.39	0.91	1.38
	Sub-Total	24.88	26.61	33.54	25.38	36.04	29.29	82.68	85.73	77.64	76.93	67.24	78.03	81.22	88.03	85.79	86.18	68.59	81.95

The physical composition in summer is 70.71% combustibles and 29.2% non-combustibles, and in the winter, these are 18.05% and 81.95%, respectively. The generation rate of briquet ash greatly influences the compositional turnover in which the rate in winter is over 5 times as much as that in summer.

In planning for solid waste management of Seoul City, separate collection of the most fluctuating component, briquet ash, needs to be considered. The composition excluding briquet ash is indicated within parentheses in Table 2-16. This shows that, other than the change in garbage, a noticeable fluctuation cannot be witnessed.

Table 2-16 Physical Composition of Waste

(wet basis wt.%)

	Components	Summer	Autumn	Winter
Combustibles	Paper	15.98 (18.47)	3.96 (15.30)	5.73 (24.08)
	Textile	2.65 (3.06)	1.27 (4.91)	1.36 (5.71)
	Garbage	36.27 (41.92)	9.93 (38.37)	4.58 (19.24)
	Wood	5.16 (5.96)	0.72 (2.78)	0.51 (2.14)
	Plastic	3.99 (4.61)	1.97 (7.61)	1.85 (7.77)
	Leather & Rubber	1.99 (2.30)	0.10 (0.39)	1.02 (4.29)
	Others	4.67 (5.40)	4.02 (15.53)	3.00 (12.61)
	Sub-total	70.71 (81.72)	21.97 (84.89)	18.05 (75.84)
Non-Combustibles	Ferrous Metals	1.95 (2.25)	0.19 (0.73)	1.22 (5.13)
	Nonferrous Metals	0.23 (0.27)	0.06 (0.23)	0.08 (0.34)
	Glass	6.13 (7.09)	0.55 (2.13)	2.21 (9.29)
	Bones, Stones & Ceramics	6.12 (7.07)	1.27 (4.91)	0.86 (3.60)
	Briquet ash	13.48 (-)	74.12 (-)	76.20 (-)
	Others	1.38 (1.60)	1.84 (7.11)	1.38 (5.80)
	Sub-total	29.29 (18.28)	78.03 (15.11)	81.95 (24.16)

Note: Values in ( ) are those with briquet ash excluded

These values are outlined in Table 2-17. The total indicates that, when briquet ash is excluded, the combustibles decrease in the winter, but a large fluctuation cannot be observed.

Table 2-17 Waste Components

(wet basis wt.%)

Component	Summer	Autumn	Winter
Combustibles	70.71 (81.72)	21.97 (84.89)	18.05 (75.84)
Non-combustibles	15.81 (18.28)	3.91 (15.11)	5.75 (24.16)
Briquet Ash	13.48 (0)	74.12 (0)	76.20 (0)

Note : Values in ( ) denote those without briquet ash

3. COLLECTION/TRANSPORTATION SYSTEM SURVEY

3-1 Objectives

This survey was carried out to comprehend the present situation of the collection/transportation system in Seoul City as well as to carry out the time motion survey for collection/transportation. The results are used for planning of the optimum master plan and short term improvement Project.

3-2 Survey Method

3-2-1 Present Situation of Collection/Transportation

All information was obtained from the Waste Management Division of Seoul City and the Cleansing Section of each Gu by interview and questionnaire survey.

3-2-2 Time Motion Survey for Collection/Transportation

For this survey, questionnaires were prepared to the Cleansing Section of each Gu to obtain the needed information. The survey was performed according to the following schedule.

First survey (Summer) : July 18 to 20, 1984

Second survey (Autumn) : November 19 to 21, 1984

Third survey (Winter) : February 1 to 5, 1985

Questionnaires for collection and transportation are shown in Table 3-2-1 and Table 3-2-2 respectively.

3-3 Results

Table 3-2-1 Questionnaire for Collection

1. Date
2. Place
3. Collection method and number of family

	Door-to-door collection	Pannier collection	Bell ringing collection
Population			
Family			

4. Collection frequency

(1) Every day (2) Every other day
(3) Every third day

5. Width of road
6. Kind of transfer station

(1) Station with ramps (2) Station without ramps
(3) Movable station (4) Container station

7. Distance between collection area and transfer station
8. Time motion

Work item	1st trip	2nd trip	--------	6th trip
Start of work	( )h( )m	( )h( )m	--------	( )h( )m
Transfer station to collection area	( ) m	( ) m	--------	( ) m
Collection time	( ) m	( ) m	--------	( ) m
Collection area to transfer station	( ) m	( ) m	--------	( ) m
Unloading time	( ) m	( ) m	--------	( ) m
Rest time	( ) m	( ) m	--------	( ) m
Finish of work	( )h( )m	( )h( )m	--------	( )h( )m

9. Collection time from a storage

(1) Concrete dust box installed inside of wall
(2) Concrete dust box installed outside of wall
(3) Plastic container
(4) Bag

Table 3-2-2 Questionnaire for Transportation

1. Date
2. Name of Gu
3. Name of Driver
4. Vehicle
   (1) 8.5 t Dump truck
   (2) 8.0 t "
   (3) 7.0 t "
   (4) 4.5 t "
   (5) 8.25 t Container
   (6) 4.0 t "
5. Transportation Route (Name of Road)
6. Time Motion

Trip	Work Item	Time
	Start of Work	( )h ( )m
	Vehicle Inspection	( )h ( )m - ( )h ( )m
	Start from Garage	( )h ( )m
1st trip	Loading Time	( )h ( )m - ( )h ( )m
	Transfer Station to Nanjido	( )h ( )m - ( )h ( )m
	Nanjido to Transfer Station	( )h ( )m - ( )h ( )m
2nd trip	Loading Time	( )h ( )m - ( )h ( )m
	Transfer Station to Nanjido	( )h ( )m - ( )h ( )m
	Nanjido to Transfer Station	( )h ( )m - ( )h ( )m
	⋮	⋮
10th trip	Loading Time	( )h ( )m - ( )h ( )m
	Transfer Station to Nanjido	( )h ( )m - ( )h ( )m
	Nanjido to Transfer Station	( )h ( )m - ( )h ( )m
	Transfer Station to Garage	( )h ( )m - ( )h ( )m
	Washing Vehicle	( )h ( )m - ( )h ( )m
	Finish of Work	( )h ( )m
	Rest (1)	( )h ( )m - ( )h ( )m
	Rest (2)	( )h ( )m - ( )h ( )m
	Lunch Time	( )h ( )m - ( )h ( )m
	Others (1)	( )h ( )m - ( )h ( )m
	Others (2)	( )h ( )m - ( )h ( )m

3-3-1 Present Situation of Collection/Transportation

The total collected solid waste quantities by Seoul City authorities and 68 commissioned private companies in 1983 are as follows.

Seoul City	4,970,383 (61.7%)	
Private Companies	3,091,234 (38.3%)	Including large-quantity generated waste (8.3%)
Total	8,061,617 tons	

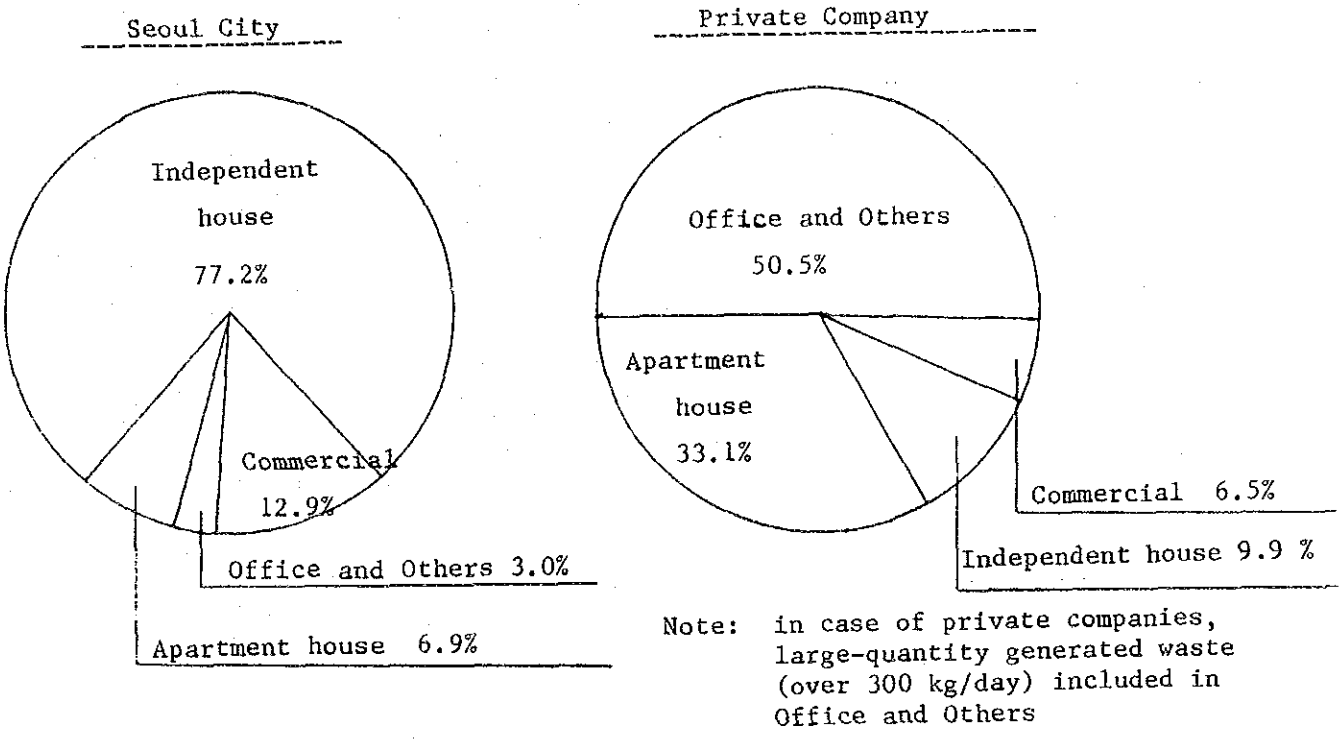


Fig. 3-3-1 Solid Waste Collection Sources

Table 3-3-1 Collection Method

Door-to-door collection by hand cart	For independent houses
Bell ringing collection by hand cart	For independent houses which located in very steep topography
Car collection	For apartment houses, offices hotels and markets

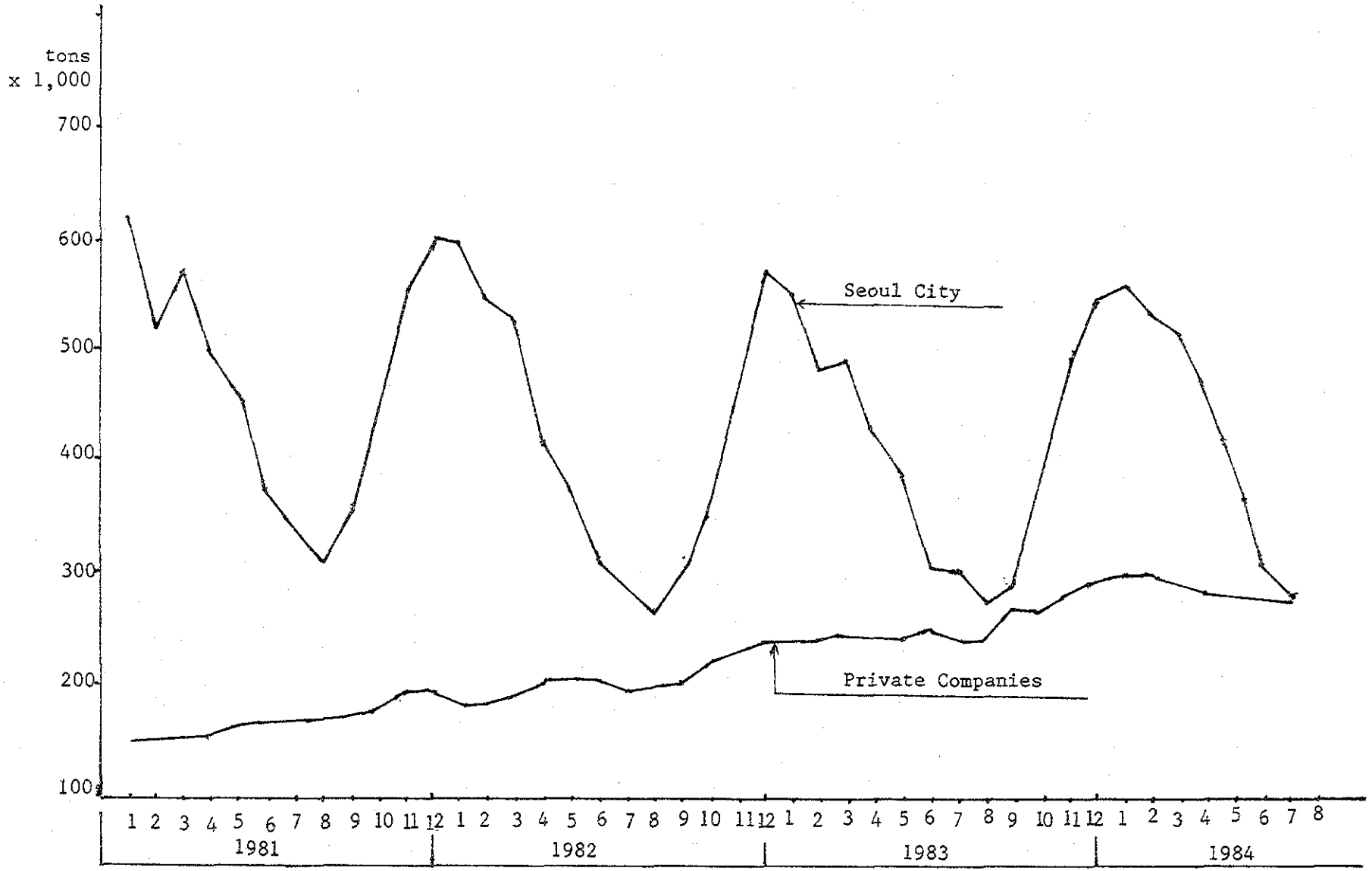


Fig. 3-3-2 Collected Solid Waste

Table 3-3-2 Storage Method

Independent houses	The storage methods in households are concrete dust boxes, plastic containers, metal cans, wooden boxes and others as shown in Table 3-3-3. The capacity of concrete dust boxes is about 200 liters and that of plastic containers is between 30 and 70 liters.
Stores and Restaurants	Small-scale stores and restaurants usually use plastic containers and drum cans. The capacity of plastic containers is between 50 and 110 liters
Apartment houses	Apartment houses are equipped with chutes and storage rooms, and ordinary residential waste and briquet ash are discharged together in the chute at apartments without central heating systems. The waste storage rooms are generally located below the ground level without consideration of collection
Office buildings, hotels and department stores	The majority of office buildings, hotels and department stores have stock rooms made of concrete or metal on their own premises. These are usually under good control.
Factories and markets	Many kinds of on-site storage methods are used by factories and markets depending on the kind and scale. Furthermore, some of the factories and markets have their own disposal site.

Table 3-3-3 Storage Method of Independent House

Type of Container	Percentage of Use
Concrete dust box	43 %
Plastic container	35 %
Metal can	8 %
Wooden box	6 %
Bag	6 %
Others	2 %

Table 3-3-4 Transfer Stations (Seoul City)

Location	Number
Along main streets	111
Along Streets	358
Open Land	149
Along Rivers	78
Total	696

Method	Number
Stations with ramps	297
Stations Withoirt ramps	158
Movable Stations	26
Container Stations	215
Total	696

Location	Number of suitable stations	Number of unsuitable stations
Along main streets	32	79
Streets and others	304	196
Open land		85
Total	336	360

Table 3-3-5 Workers' School Education

Graduated High school	Leave High School	Graduated Secondary School	Graduated Primary School	Leave Primary School	Total
505	227	2,212	4,541	925	8,410
(6%)	(3%)	(26%)	(54%)	(11%)	(100%)

Note: Including drivers and mechanics

Table 3-3-6 Workers' Age

More than 50 years	More than 45 years	More than 40 years	More than 35 years	Less than 35 years	Total
765	1,707	2,363	1,993	1,582	8,410
(9%)	(20%)	(28%)	(24%)	(19%)	(100%)

Note: Including drivers and mechanics

Table 3-3-7 Accidents on Duty

(Persons)

	1981		1982		1983	
	Killed	Injured	Killed	Injured	Killed	Injured
Collection Workers	2	73	12	69	15	104
Street Sweepers	5	159	5	144	8	152
Total	7	232	7	213	23	256

Table 3-3-8 Street Length to be Cleaned (Seoul City)

(m)

Street / Gu	Width of main street			Total
	More than 40m	25 - 35m	12 - 20m	
Jongro	6,780	19,165	25,114	51,059
Jung	7,650	15,420	17,994	41,064
Yongsan	10,370	33,870	24,735	68,975
Seongdong	3,540	33,080	50,879	87,499
Dongdaemun	4,600	43,791	39,210	87,601
Seongbug	-	18,500	30,815	49,315
Dobong	5,900	24,550	32,580	63,030
Eunpyung	1,450	27,820	15,850	45,120
Seodaemun	5,270	21,029	15,033	41,332
Mapo	4,600	16,512	31,410	52,522
Gangseu	15,040	26,200	27,721	68,961
Guro	12,897	17,020	31,857	61,774
Yeoungdeungpo	4,800	33,705	35,641	74,146
Dongjag	2,750	15,250	18,575	36,575
Gwanag	7,400	7,385	21,386	36,171
Gangnam	48,511	44,320	65,105	157,936
Gangdong	16,272	25,150	48,161	89,583
Total	157,830	422,767	532,066	1,112,663

Table 3-3-9 Vehicles of Seoul Municipality

(April, 1984)

Name of Gu and Municipality	Collection and Transportation Vehicles (Tons)										Other Vehicles			Container box (m3)		Hand Cart
	8.5	8.25*	8.0	7.0	6.0	4.5	4.0*	2.5	2.0	Total	Road Sweeper	Loader or (dozer)	Patrol Car	16.6	8.2	
Jong-ro-Gu	7	6	4	2	1	1	9	2	-	32	2	2	1	30	34	491
Jung-Gu	1	5	2	2	-	2	2	-	-	14	2	-	1	25	7	453
Yongsan-Gu	8	3	6	-	-	1	5	-	1	24	-	-	1	15	15	349
Seongdong-Gu	26	2	9	3	-	2	5	-	-	47	1	-	1	10	25	588
Dongdaemun-Gu	27	3	8	1	-	6	8	-	-	53	-	1	1	15	32	743
Seongbug-Gu	21	1	8	2	-	5	6	-	-	43	-	1	1	5	30	497
Dobong-Gu	19	1	8	2	-	7	7	-	-	44	-	1	1	5	38	558
Eunpyeong-Gu	9	1	9	2	-	2	6	-	-	29	-	1	1	5	28	340
Seodaemun-Gu	10	1	5	2	-	2	11	-	-	31	-	1	1	5	55	392
Mapo-Gu	10	2	3	1	1	2	9	-	-	28	1	(1)	1	10	35	435
Gangseo-Gu	13	1	2	-	-	5	7	-	-	28	1	-	1	5	35	364
Guro-Gu	10	1	6	2	-	4	4	1	-	28	-	-	1	5	20	412
Yeongdeungpo-Gu	4	2	3	1	1	3	7	-	1	22	1	-	1	10	28	415
Dongjag-Gu	9	1	6	1	-	3	6	-	-	26	1	1	1	5	30	350
Gwanak-Gu	14	1	6	2	-	4	3	-	-	30	-	2	1	5	15	360
Gangnam-Gu	3	1	2	-	-	1	1	-	-	8	1	-	1	5	5	260
Gangdong-Gu	11	2	8	-	-	2	2	-	-	25	2	-	1	10	10	299
Municipality	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-
Total	202	34	95	23	3	52	98	3	2	512	12	10	20	170	442	7,306

Note : * Vehicles for Containers

Table 3-3-10 Workers and Drivers of Seoul Municipality

(April, 1984)

Name of Gu and Municipality	Workers			Drivers				Mechanic and Carpenter	Inspector and Guard	Total
	Collection Workers	Street Sweeper	Total	Collection Car	Heavy Car	Patrol Car	Total			
Jongro-Gu	256	225	481	32	4	1	37	6	7	531
Jung-Gu	146	198	344	14	2	1	17	4	6	371
Yongsan-Gu	211	163	374	24	-	1	25	4	6	409
Seongdong-Gu	482	187	669	47	1	1	49	7	8	733
Dongdaemun-Gu	564	213	777	53	1	1	55	9	8	849
Seongbug-Gu	412	132	544	43	1	1	45	7	7	603
Dobong-Gu	518	93	611	44	1	1	46	7	6	670
Eunpyeong-Gu	285	86	371	29	1	1	31	5	6	413
Seodaemun-Gu	328	88	416	31	1	1	33	5	6	460
Mapo-Gu	296	139	435	28	3	1	32	5	24	496
Gangseo-Gu	304	91	395	28	-	1	29	5	6	435
Guro-Gu	293	125	418	28	-	1	29	4	7	458
Yeongdeungpo-Gu	221	197	418	22	1	1	24	4	6	452
Dongjag-Gu	273	86	359	26	2	1	29	4	6	398
Gwanak-Gu	297	88	385	30	2	1	33	4	7	429
Gangnam-Gu	103	177	280	8	1	1	10	3	5	298
Gangdong-Gu	205	151	356	25	2	1	28	3	6	393
Municipality	-	-	-	-	-	2	2	-	10	12
Total	5,194	2,439	7,633	512	23	19	554	86	137	8,410

Table 3-3-11 Workers and Vehicles of Private Companies

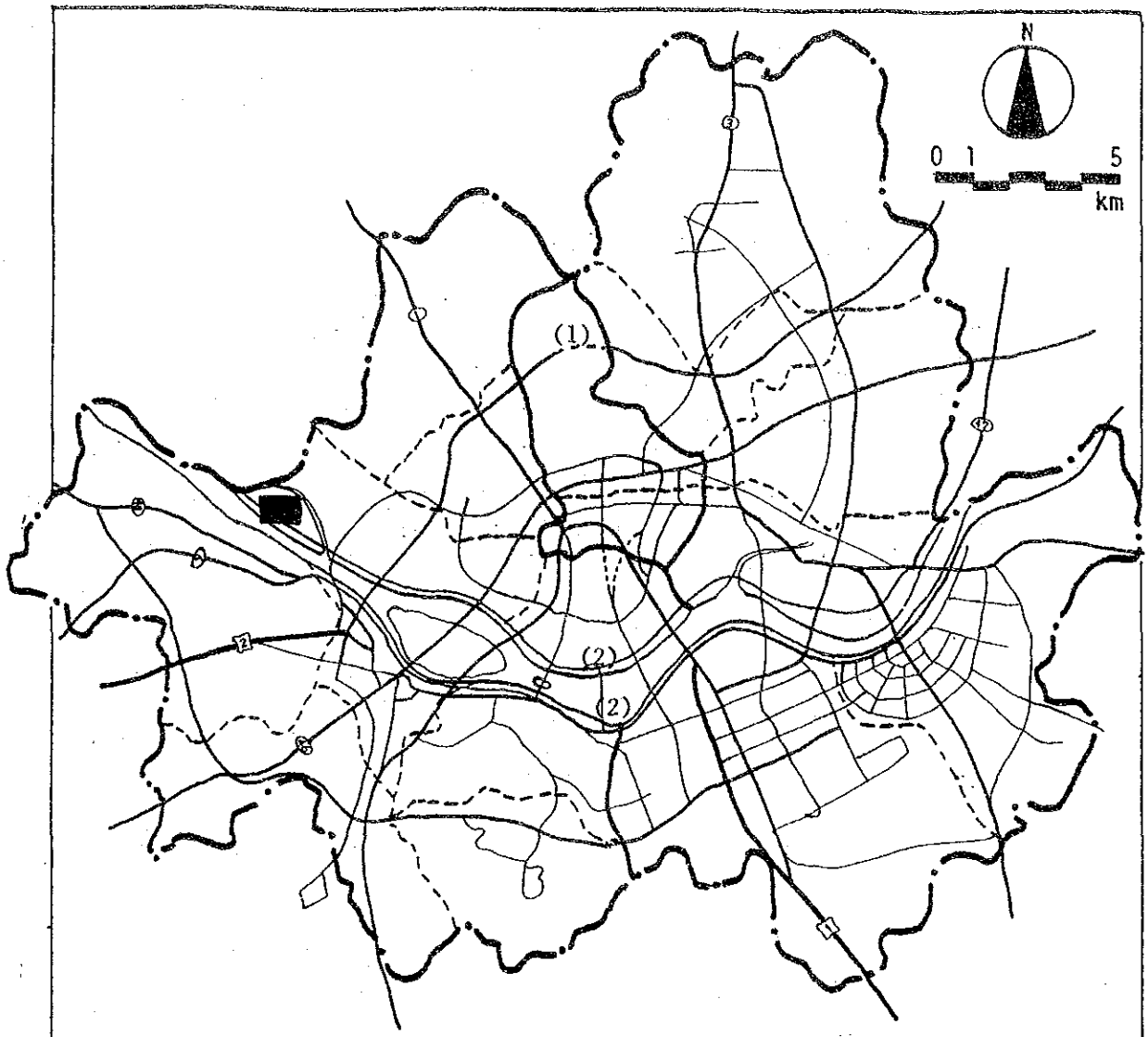
(December, 1983)

Name of Gu	Number of Private Compaines	Number of Workers		Number of Vehicles		
		Collection Workers	Drivers	Vehicles	Container Box	Hand Cart
Jungro-Gu	3	166	19	16	16	192
Jung-Gu	6	373	33	29	41	377
Yongsan-Gu	6	121	27	23	5	110
Seongdong-Gu	2	89	16	12	-	100
Dongdaemun-Gu	3	81	18	9	9	125
Seongbug-Gu	2	19	5	5	5	11
Dobong-Gu	2	48	8	8	-	15
Eunpyeong-Gu	1	22	6	5	9	-
Seodaemun-Gu	1	44	6	6	6	60
Mapo-Gu	2	18	4	4	-	10
Gangseo-Gu	4	110	22	22	5	40
Guro-Gu	7	202	30	30	23	138
Yeongdeungpo-Gu	8	174	31	27	8	89
Dongjag-Gu	3	54	7	7	-	11
Gwanak-Gu	2	27	8	8	-	-
Gangnam-Gu	10	379	50	50	13	412
Gangdong-Gu	6	253	34	28	16	129
Total	68	2,180	324	289	156	1,819

Table 3-3-12 Vehicles and Haul Distances (Seoul City)

(April, 1984)

Name of Gu	Number of vehicles	Total loading capacities (tons)	Round-trip distance (km)
Jongro-Gu	32	212.5	26
Jung-Gu	14	99	28
Yongsan-Gu	24	170	22
Seongdong-Gu	47	362.5	45
Dongdaemun-Gu	53	389	47
Seongbug-Gu	43	314.5	34
Dobong-Gu	44	311	45
Enpyeong-Gu	29	207.5	21
Seodaemun-Gu	31	206	18
Mapo-Gu	28	187.5	16
Gangseo-Gu	28	189	20
Guro-Gu	28	195.5	29
Yeongdeungpo-Gu	22	135	18
Dongjag-Gu	26	180.5	29
Gwanak-Gu	30	222	31
Gangnam-Gu	8	59	48
Gangdong-Gu	25	192.5	62
Total	512	3,633	32 (Average)



Disposal Site (Nanjido)

(1) Second Ring Road

(2) Roads along the Han River

Fig. 3-3-3 Main Transportation Route of Solid Waste

3-3-2 Time Motion Survey Results

(1) Collection

Sampling numbers of survey are listed below;

1st survey (Dongdaemun-Gu and Seongbug-Gu) ------- 60
2nd survey (17-Gu) ---------- 152
3rd survey (17-Gu) ---------- 83

Table 3-3-13 Collection Frequency

Frequency	1st Survey		2nd Survey		3rd Survey	
	Samples	%	Samples	%	Samples	%
Every day	3	5	17	11	4	5
Every other day	37	62	72	48	44	53
Every 2nd day	20	33	63	41	35	42
Total	60	100	152	100	83	100

Table 3-3-14 Starting Time for Collection

Time (o'clock)	1st Survey		2nd Survey		3rd Survey	
	Samples	%	Samples	%	Samples	%
22 - 23	-	-	3	2	-	-
23 - 24			10	7	-	-
24 - 1	4	7	5	3	1	1
1 - 2	12	20	6	4	4	5
2 - 3	28	46	5	3	6	7
3 - 4	12	20	7	4	12	15
4 - 5	2	3	32	21	14	17
5 - 6	1	2	57	37	20	24
6 - 7	1	2	24	16	25	30
7 - 8	-	-	-	-	1	1
¦	¦	¦	¦	¦	¦	¦
12 - 1	-	-	1	1	-	-
15 - 16	-	-	1	1	-	-
17 - 18	-	-	1	1	-	-
Total	60	100	152	100	83	100

Table 3-3-15 Number of Trips

Number of Trips	1st Survey		2nd Survey		3rd Survey	
	Samples	%	Samples	%	Samples	%
2	16	27	-	-	-	-
3	35	58	2	1	1	1
4	9	15	30	20	14	17
5	-	-	99	65	33	40
6	-	-	21	14	35	42
Total	60	100	152	100	83	100
Average	2.9 Trips		4.9 Trips		5.2 Trips	

Table 3-3-16 Collection Time per Trip

Collection Times	1st Survey		2nd Survey		3rd Survey	
	Samples	%	Samples	%	Samples	%
h m h m						
1:30- 2:00	20	33	47	31	20	24
2:00- 3:30	26	44	64	42	38	46
2:30- 3:00	14	23	33	22	23	28
3:00- 3:30	-	-	8	5	2	2
Total	60	100	152	100	83	100
Average	2h 12m		2h 15m		2h 17m	

Note : Unloading time and rest time are included in collection times.

Table 3-3-17 Motion per Trip

Motion	Time (minutes)
In mortion to collection area	5 - 25
Collection	30 - 100
In mortion to transfer station	10 - 50
Rest	5 - 25
Unloading onto dump truck	30 - 60

Note ; Unloading is performed on time per two or three trips.

Table 3-3-18 Collection Time from a Storage

Time (minutes)	Concrete dust box inside of wall (%)	Concrete dust box outside of wall (%)
2	-	12
3	8	29
4	14	16
5	35	27
6	6	3
7	12	5
8	3	5
9	2	-
10	17	3
15	3	-
Total	100	100
Average	6m 24 sec	4m 18 sec

Time (minutes)	Plastic Container (%)	Bag (%)
0.5	4	13
1	52	57
2	20	19
3	13	11
4	2	-
5	9	-
Total	100	100
Average	1m 50 sec	1m 21 sec

(2). Transportation

Sampling numbers of survey are listed below;

1st survey (17 - Gu) ------- 99
2nd survey (17 - Gu) ------- 169
3rd survey (17 - Gu) ------- 101

Table 3-3-19 Starting Time for Transportation

Time (o'clock)	1st Survey		2nd Survey		3rd Survey	
	Samples	%	Samples	%	Samples	%
0 - 1	1	1	5	3	2	2
1 - 2	4	4	3	2	5	5
2 - 3	9	9	17	10	8	8
3 - 4	10	10	12	7	9	9
4 - 5	18	18	31	18	9	9
5 - 6	47	48	77	46	44	43
6 - 7	6	6	21	12	21	21
10 - 11	-	-	-	-	1	1
12 - 13	-	-	1	1	1	1
13 - 14	1	1	-	-	1	1
14 - 15	1	1	-	-	-	-
15 - 16	2	2	-	-	-	-
16 - 17	-	-	2	1	-	-
Total	99	100	169	100	101	100

Note: Starting time is when driver start works at the garage.

Table 3-3-20 Number of Trips

Gu	1st Survey						2nd Survey						3rd Survey				
	Number of Trip					Average Trip	Number of Trip					Average Trip	Number of Trip				Average Trip
	2	3	4	5	6		2	3	4	5	6		3	4	5	6	
Jongro	-	2	3	1	-	3.8	-	2	4	2	2	4.4	-	2	3	1	4.8
Jung	2	2	2	-	-	3.0	-	-	2	4	2	5.0	-	-	1	5	5.8
Yongsan	-	2	-	3	1	4.5	-	1	1	5	3	5.0	-	-	-	6	6.0
Seongdong	-	1	3	1	-	4.0	-	2	2	3	4	4.8	-	2	2	2	5.0
Dongdaemun	-	3	3	-	-	3.5	-	-	5	5	-	4.5	-	3	3	-	4.5
Seongbug	3	2	1	-	-	2.7	-	1	7	1	1	4.2	-	3	1	2	4.8
Dobong	1	1	4	2	-	3.4	1	1	5	3	-	4.0	-	3	3	-	4.5
Eunpyung	-	2	1	-	3	4.7	-	-	1	4	5	5.4	-	-	1	5	5.8
Seodaemun	1	1	2	-	2	4.2	-	-	3	1	6	5.3	-	-	3	3	5.5
Mapo	-	-	-	4	2	5.3	-	-	-	3	7	5.7	-	1	-	5	5.7
Gangseo	-	1	2	2	1	4.5	-	-	-	4	6	5.6	-	-	2	4	5.7
Guro	-	1	3	-	-	4.8	-	1	1	1	8	5.5	-	-	-	6	6.0
Yeoungdeungpo	1	-	-	2	3	5.0	-	-	3	1	6	5.3	-	2	3	1	4.8
Dongjag	1	1	2	1	1	4.0	-	1	4	3	3	4.7	-	-	3	3	5.5
Gwanak	1	2	3	-	-	3.3	-	-	4	4	2	4.8	-	3	1	2	4.8
Gangnam	1	-	3	1	-	3.8	1	1	3	1	2	4.3	3	1	1	1	4.0
Gangdong	3	2	-	-	-	2.4	3	3	4	-	-	3.1	2	3	-	-	3.6
Total	14	23	32	17	13	3.9	5	13	49	45	57	4.8	5	23	27	46	5.2

Table 3-3-21 Motion per Trip

Motion	Time (minutes)
Vehicle inspection	5 - 20
Garage to transfer station	5 - 25
Loading . Dump truck	30 - 50
. Container	10 - 15
Transfer station to Nanjido	15 - 70
Unloading	10
Nanjido to transfer station	15 - 70
Transfer station to garage	5 - 25
Washing vehicle	20 - 40

Notes; 1. The garage for Jongro, Jung, Seongbug and Dongdaemun-Gu is located in Seongdong-Gu.
2. Vehicle speed is 25 - 40 km/hour.

Table 3-3-22 Working Hour per Day

1st Survey	2nd Survey	3rd Survey
$6^h:00^m$ - $7^h:00^m$	$10^h:30^m$ - $11^h:30^m$	$11^h:30^m$ - $12^h:30^m$

3-4 Considerations

3-4-1 General

(1) Old Traditional Residential Areas

Many narrow path and alleys of less than 3.0m width are found in old traditional residential areas (about 35% of dependent households). It is probably the reason why the hand cart collection system is effectively adopted and the car collection system has fallen behind. The width of an alley is often too narrow to let waste collection hand carts in and sometimes an alley is nothing but a foot path, although there are many residences along it requiring waste collection services. Under such circumstances, effective waste collection is very difficult.

According to the new building code (1972), all houses should face roads of more than 4.0 m width. Hence, the new towns which have been built in the last 10 years are considered to be good residential areas.

(2) Monthly Variation of Solid Waste

As shown in Fig. 3-3-2, variation of collected solid waste in month is very large for Seoul City. On the other hand, private companies have few variations because the solid waste collected by Seoul City are mainly from independent houses which discharge briquet ash in the winter season. Ratio between maximum and minimum discharged month, collected by Seoul City in 1983 is

553,800 t(Jan.)/277,900 t (Aug.) = 2.0

Seasonal variation collected by Seoul City is as follows:

June, July and August	= 0.71
March, April, May, September and October	= 0.97
November, December, January and February	= 1.25
Average per month in a year	= 1.00

(3) Working Hours

According to the working regulation for collection workers and drivers, the working hour is 9 hours including one hour rest time per day in principle as shown below:

Day time collection ; April to October ..... 5:30 to 14:30
November to next March.... 6:30 to 15.30
Night time collection; Between sunset and sunrise

Night time collection is undertaken in the Central Bussiness District (CBD), as shown below:

Jongro-Gu	.....	14 Dongs
Jung-Gu	.....	8 "
Dongdaemun-Gu	.....	3 "
Yeongdeungpo-Gu	.....	1 "

Actually, collection workers and driver start work more early in the morning in order to avoid traffic jams as shown in Table 3-3-14 and Table 3-3-19.

According to the survey results, working hours per day are as follow:

Collection worker

1st survey	;	2h 12m x 2.9 trips	= 6h : 20m
2nd survey	;	2h 15m x 4.9 "	= 11h : 00m
3rd survey	;	2h 17m x 5.2 "	= 11h : 50m

Driver

1st survey	;	6h : 00m	-	7h : 00m
2nd survey	;	10h : 30m	-	11h : 30m
3rd survey	;	11h : 30m	-	12h : 30m

Working hours are proportionate to the discharged waste volume (refer to 3-4-1 (2)) and average working hour per day in a year is about 9 hours. Management of collection workers and drivers is very important matter, especially since overwork is undertaken in the winter season.

3-4-2 Collection

(1) Storage Method

Concrete dust boxes installed on the outside or inside of walls surrounding independent residences occupy about 50 % of all storage methods. The collection efficiency to take out waste from these concrete dust boxes is extremety low as shown in Table 3-3-18.

Many large buildings, apartments and offices are equipped with dust chutes, which are used as solid waste storage pits. The waste storage rooms are generally located below the ground level without consideration of collection works. Therefore, the storage area becomes more unsanitary due to leachate formation propelled by rain water and odor generation and furthermore storage rooms become nesting places for rats and insects. The collection workers have to transfer these wastes from its small outlet into baskets and convey them to hand carts or collection trucks; hence the operation efficiency is very low. Ordinary domestic waste and briquet ash are stored together at apartment houses without central heating system and it makes difficulty of separate collection.

(2) Collection Frequency

According to the refuse cleansing law, solid waste should be collected everyday in principle, but at least one time per three days. In actuality, collection workers collect solid waste 2 - 3 times per week and everyday for small-scale stores and restaurants as shown in Table 3-3-13.

(3) Collection Workers

Each collection worker has his duty area which was arranged according to physical conditions such as topography, road conditions and situation of areas, age of workers, and traffic conditions. Sometimes, rotation of

duty area for collection workers are undertaken for their working conditions. The duty area for one collection worker covers about 200 - 250 households (900 - 1,125 persons). 2,477 road-sweeping personnel clean the streets and side walks covering a length of 1,110 km (width is over 12 m) shown in Table 3-3-8, and also they collect solid waste from small-scale stores and restaurant along the streets. They usually finished their first cleaning work on street before 8 : 30 an and clean at least 4-times a day on their own duty road with a length of about 450m. That is the reason for the very clean streets and sidewalks in Seoul.
Accident on duty are shown in Table 3-3-7. Collection workers' accidents are mainly slips on frozen sloped roads in the winter season, and street sweeper's accidents are mainly traffic accidents in the night time.
In consequence, safety measures for street sweepers, such as hand carts with reflections plates and reflective clothes have been provided starting in 1984. Therefore, accident are expected to be reduced.

(4) Transfer Station

There are 696 small scale transfer stations to unload solid waste from hand cart onto dump trucks or containers. The number, locations and methods of transfer stations are shown in Table 3-3-4. Manual unloading methods are applied in most cases. Seoul authorities use only 9 loaders for the unloading operation at a few stransfer stations. These transfer stations are located alongside streets, rivers and open land areas, and are enclosed with simple metal fences. However citizens have been complained about them due to dusts, odors, unaesthetic appearances and unsanitary conditions.

3-4-3 Transportation

(1) Vehicles

The number and type of vehicles of Seoul City are shown below:

Dump truck	(8.0 - 8.5 t)	----------	297 (58%)
"	(6.0 - 7.0 t)	----------	26 (5%)
"	(2.0 - 4.5 t)	----------	57 (11%)
Container truck	(8.25t, 16.6 m^3)	-----	34 (7%)
"	(4.0t, 8.2 m^3)	-----	98 (19%)
Average (7.0 t)		Total	512 (100%)

Dump trucks (8.0 - 8.5 t) and container trucks are mainly used as transportation vehicles. Large number of 8.5 t - dump trucks are arranged for Seongdong-Gu, Dongdaemun-Gu, Seongbug-Gu and Dobong-Gu which are located far from the disposal site, Nanjido.
8.25 t - container trucks are mainly arranged for the central Business District (CBD) of Jongro-Gu and Jung-Gu and the shopping areas have no open land areas for transfer stations.

(2) Number of Trips and Transportation Routes

Number of trips of vehicles between transfer stations and the disposal site (Nanjido) are 2.5 - 6.0. Solid waste has mainly been transported on the Second Ring Road and the roads along the Han River to the disposal site (Nanjido) to avoid traffic congestions.

4. FINAL DISPOSAL SYSTEM SURVEY

4-1 Objectives

This survey was carried out to determine the present situation of final disposal for municipal solid waste collected from Seoul City. To accomplish this, the number of trucks used for disposal and the truck loading rates were surveyed three times to determine any seasonal fluctuations. The survey was performed according to the following schedule.

First survey (Summer)	:	July 25, 27 and 30, 1984
Second survey (Autumn)	:	November 21, 23, and 26, 1984
Third survey (Winter)	:	January 30, 31 and February 1, 1985

The results will supplement other collected data to determine truck loading densities, disposal rates and other pertinent information to propose the optimum master plan and short term improvement project.

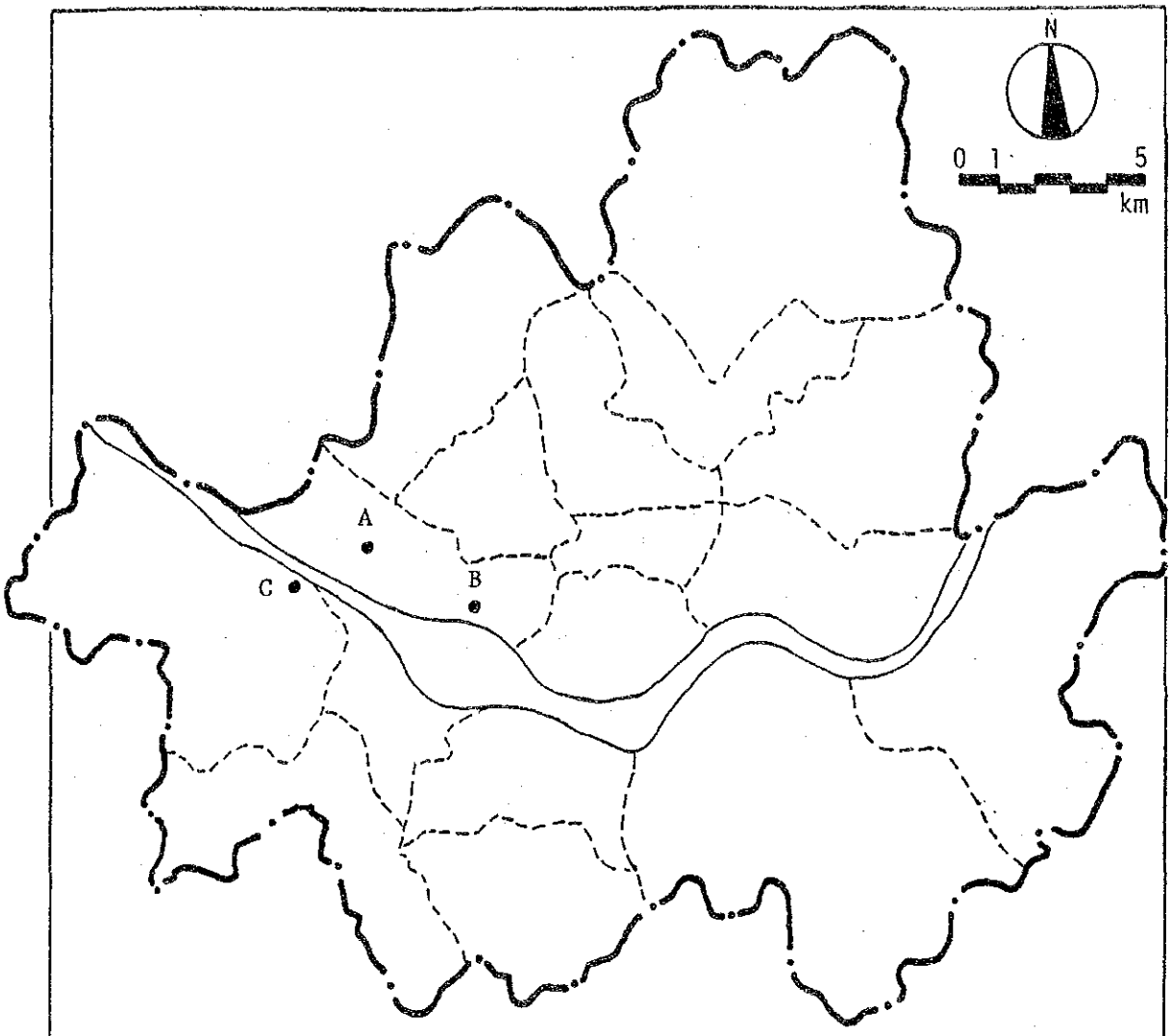
4-2 Survey Method

4-2-1 Truck Loading Rate Survey

Selected trucks from each Gu were asked to make stop overs to one of the three designated truck scales shown in Fig. 4-1. The number of trucks requested to each Gu office is listed in Table 4-1.

The truck drivers were requested to stop by the scale each time they made a trip to Nanjido with their loaded tracks for a full-day's work. Furthermore, only on their first trip back from Nanjido, the empty trucks were weighed.

This weighing was carried out for three days during each of the three surveys. The first two surveys were performed on three alternate days, but confirmation of the actual survey days caused confusion. Therefore, the third survey was conducted during three consecutive days.



Truck Scale A : Jung San Dong, Mapo Gu

Truck Scale B : Yong Gang Dong, Mapo Gu

Truck Scale C : Yom Chang Dong, Gangseo Gu

Fig. 4-1 Location of Truck Scales for Survey

Table 4-1 List of Trucks for Scaling Survey

Gu Name	Designated Truck Scale	Number of Trucks for Survey		
		Gu	Private	Total
Jongro	A	1	1	2
Jung	B	1	1	2
Yongsan	B	0	1	1
Seongdong	B	1	0	1
Dongdaemun	B	1	1	2
Seongbuk	A	1	0	1
Dobong	A	0	1 (0)	1 (0)
Eunpyeong	A	1	0	1
Seodaemun	A	0	1	1
Mapo	B	1	0	1
Gangseo	C	1	0	1
Guro	C	0	1	1
Yeongdeungpo	C	0	1	1
Dongjak	C	1	0	1
Gwanak	C	1	0	1
Gangnam	C	0	1	1
Gangdong	C	1	0	1
Total		11	9 (8)	20 (19)

Note: figures in parentheses denote those for the first survey only.

4-2-2 Final Disposal Rate Survey

Trip numbers of dump trucks to final disposal sites are summarized by each Gu. Disposal rates were estimated with the trip numbers and truck capacities. Three days were decided as the survey date for three seasons (summer, autumn and winter), which are on the same days as the truck loading rate surveys were carried out in order to give correspondence.

4-3 Results

The results of surveys on truck loading rate and final disposal rate are compiled in Tables 4-2 to 4-4 and Tables 4-5 to 4-7, respectively.

Table 4-2 Truck Loading Rate in Summer

Truck Loading Rate	Number of Trucks by Capacity				Truck Loading Rate	Number of Trucks by Capacity				Truck Loading Rate	Number of Trucks by Capacity			
	4.5t	8.0t	8.25t	8.5t		4.5t	8.0t	8.25t	8.5t		4.5t	8.0t	8.25t	8.5t
0.00					0.50				4	1.00	1			
1					1	1				1	1			
2					2				2	2				
3					3	3			2	3				
4					4	2			1	4				
5				1	5				1	5	1			
6					6				1	6	1			
7	1				7	2				7				
8					8				3	8	1			
9					9	1			1	9	1			
0.10					0.60	2	1		1	1.10				
1					1				3	1				
2	1				2				3	2				
3	1				3	1			3	3				
4	1				4				3	4				
5					5	1			3	5				
6				1	6	2			2	6				
7					7	2			6	7	1			
8				1	8	4			3	8				
9				2	9				2	9				
0.20				2	0.70	3			1	1.20				
1				1	1	1			1	1				
2				2	2				6	2				
3				1	3				3	3				
4				1	4	3			4	4				
5				1	5				5	5				
6					6	2			2	6				
7					7					7				
8	1				8	2			1	8				
9	1				9	1			1	9				
0.30	1			1	0.80	1			1	1.30	1			
1				1	1	2				1				
2					2				2	2				
3				2	3	3			1	3	1			
4				1	4				2	4	1			
5				1	5	5			1	5				
6	1				6				2	6	1			
7					7				1	7				
8					8	1			1	8	1			
9					9	2			1	9				
0.40	2				0.90	2				1.40				
1	1				1	1			1	1				
2	1			2	2	2			3	2				
3				1	3					3				
4	1	1			4	3				4				
5				1	5					(1.63)	1			
6				1	6	1				(1.56)	1			
7				1	7					(1.66)	1			
8	1			2	8				1	Total	89	2	0	112
9	1				9					Average Loading Rate	0.75	0.52	-	0.60

Table 4-3 Truck Loading Rate in Autumn

Truck Loading Rate	Number of Trucks by Capacity				Truck Loading Rate	Number of Trucks by Capacity				Truck Loading Rate	Number of Trucks by Capacity			
	4.5t	8.0t	8.25t	8.5t		4.5t	8.0t	8.25t	8.5t		4.5t	8.0t	8.25t	8.5t
0.00					0.50					1.00	1			
1					1					1	2			
2					2				2	2	2			
3					3					3	1			
4	1				4					4				1
5					5					5				
6					6				2	6				
7					7				2	7	3			
8					8	1				8	1			
9					9					9				
0.10					0.60	1				1.10	1			
1					1					1	1			
2					2	2			1	2				3
3	1				3				2	3	2			2
4					4	1			1	4	1			
5	1				5				3	5	1			1
6					6	1			2	6	1			
7					7	1			3	7				
8					8	1				8	1			1
9					9	2			5	9				
0.20					0.70	5			8	1.20				2
1					1	3		1	5	1	2			1
2					2				5	2				
3					3				5	3				1
4					4		1		7	4				
5	1				5	1			5	5				
6					6	1			2	6				
7					7	1			5	7				
8					8				6	8	1			
9					9				3	9				
0.30					0.80				8	1.30				
1					1	3			2	1	1			
2					2	2			7	2				1
3					3				6	3	1			
4					4	1			5	4				
5					5				4	5				
6					6		1		10	6				
7					7	3				7				
8					8	4		1	4	8				1
9					9	1			1	9				
0.40					0.90	1			3	1.40				
1					1				1	1				
2				1	2	1			2	2				
3				1	3	2		1	1	3				
4					4				2	4				
5					5	1				( )				
6					6	1			1	( )				
7	1			2	7				1	( )				
8	1			1	8	1			1	Total	72	2	3	153
9	1				9					Average Loading Rate	0.84	0.80	0.84	0.80

Table 4-4 Truck Loading Rate in Winter

Truck Loading Rate	Number of Trucks by Capacity				Truck Loading Rate	Number of Trucks by Capacity				Truck Loading Rate	Number of Trucks by Capacity			
	4.5t	8.0t	8.25t	8.5t		4.5t	8.0t	8.25t	8.5t		4.5t	8.0t	8.25t	8.5t
0.00					0.50	1				1.00				2
1					1					1	1			1
2					2	1				2	1			2
3					3				2	3	2			
4					4					4	2			3
5					5					5				1
6					6					6				1
7					7					7				
8					8	1			1	8	1			1
9					9					9				1
0.10					0.60				1	1.10				
1					1					1	2			1
2					2	2			1	2				
3					3	1			2	3				
4					4				2	4				1
5					5	2			2	5				
6					6				1	6	1			
7	1				7				3	7				
8					8				2	8				1
9					9	1			2	9				
0.20					0.70	3			3	1.20				1
1					1	1	1		3	1				2
2					2				5	2				
3					3	1			1	3				2
4					4			1	6	4				1
5					5			1	3	5				
6					6	2			2	6	1			1
7					7	2			7	7	1			
8					8	1			8	8				
9					9	2			5	9				
0.30					0.80	2		2	11	1.30				
1					1		1	1	5	1				1
2					2	2			3	2				
3					3	1			5	3	1			
4					4	2		1	3	4	1			
5					5	1			8	5				
6					6	1		1	5	6	1			
7					7	1			2	7				
8					8	3			1	8				
9					9				3	9				
0.40	1				0.90	5			5	1.40	1			
1					1	2				1				
2					2	2			3	2				
3					3	1			2	3				
4					4	4			1	4				
5					5	1			2	(1.49)	1			
6					6	1	1		2	( )				
7				1	7				2	( )				
8					8	2			2	Total	76	3	7	
9					9	5			1	Average Loading Rate	0.89	0.83	0.80	0.84

Table 4-5 Trip Numbers of Dump Trucks and Disposal Rate in Summer

Date	July 25th, Wed.			July 27th, Fri.			July 30th, Mon.		
Category Capacity (ton)	Seoul City	Private Companies	Total	Seoul City	Private Companies	Total	Seoul City	Private Companies	Total
10.5	0	0	0	0	0	0	0	0	0
8.5	589	127	716	554	128	682	597	125	722
8.25	22	0	22	27	0	27	29	0	29
8.0	193	52	245	173	53	226	180	69	249
7.0	15	0	15	17	0	14	12	0	12
6.5	0	17	17	0	14	14	0	20	20
6.0	4	31	35	4	28	32	4	28	32
4.5	355	832	1,187	355	828	1,183	391	839	1,230
4.0	94	25	119	92	26	118	106	21	127
2.75	0	14	14	0	14	14	0	14	14
2.5	0	0	0	0	0	0	0	0	0
2.0	0	0	0	0	0	0	0	0	0
Road Sweeper	0	0	0	0	0	0	0	0	0
Total	1,272	1,098	2,370	1,219	1,091	2,310	1,319	1,116	2,435
Disposal Rate (In nominal ton)	8,835	5,675	14,510	8,403	5,640	14,043	9,045	5,811	14,856
Truck Loading Rate		0.64			0.64			0.64	
Adjusted Disposal Rate (In ton)	5,660	3,630	9,290	5,380	3,610	8,990	5,790	3,720	9,510

Table 4-6 Trip Numbers of Dump Trucks and Disposal Rate in Autumn

Date	Nov. 21st, Wed.			Nov. 23rd, Fri.			Nov. 26th, Mon.		
Category / Capacity (ton)	Seoul City	Private Companies	Total	Seoul City	Private Companies	Total	Seoul City	Private Companies	Total
10.5	0	10	10	0	10	10	0	8	8
8.5	969	203	1,172	929	223	1,152	949	213	1,162
8.25	157	10	167	174	9	183	176	10	186
8.0	341	92	433	271	108	379	280	101	381
7.0	7	0	7	7	0	7	3	0	3
6.5	0	26	26	0	24	24	0	21	21
6.0	11	52	63	8	50	58	9	51	60
4.5	607	1,149	1,756	614	1,180	1,794	657	1,151	1,808
4.0	140	8	148	137	7	144	156	8	164
2.75	0	0	0	0	0	0	0	0	0
2.5	7	0	7	7	0	7	6	0	6
2.0	0	0	0	0	0	0	0	0	0
Road Sweeper	0	0	0	0	0	0	0	0	0
Total	2,239	1,550	3,789	2,147	1,611	3,758	2,236	1,563	3,799
Disposal Rate (In nominal ton)	15,684	8,332	24,016	14,925	8,733	23,658	15,429	8,439	23,868
Truck Loading Rate		0.81			0.81			0.81	
Adjusted Disposal Rate (In ton)	12,700	6,750	19,450	12,090	7,070	19,160	12,500	6,830	19,330

Table 4-7 Trip Numbers of Dump Trucks and Disposal Rate in Winter*

Date	Jan. 30th, Wed.			Jan. 31st, Thu.			Feb. 1st, Fri.		
Category Capacity (ton)	Seoul City	Private Companies	Total	Seoul City	Private Companies	Total	Seoul City	Private Companies	Total
10.5	0	28	28	0	26	26	0	28	28
8.5	1,135	243	1,378	1,088	255	1,343	945	245	1,190
8.25	117	21	138	118	20	138	83	21	104
8.0	378	62	440	404	64	468	363	65	428
7.0	14	0	14	7	0	7	3	0	3
6.5	0	34	34	0	39	39	0	34	34
6.0	0	16	16	8	13	21	4	17	21
4.5	698	861	1,559	752	862	1,614	644	836	1,480
4.0	47	0	47	42	0	42	45	0	45
2.75	0	0	0	0	0	0	0	0	0
2.5	2	0	2	9	0	9	4	0	4
2.0	-	-	-	4	0	4	0	0	0
Road Sweeper	1	0	1	2	0	2	2	0	2
Total	2,392	1,265	3,657	2,434	1,279	3,713	2,093	1,246	3,339
Disposal Rate (In nominal ton)	17,069	7,220	24,289	17,133	7,328	24,461	14,754	7,155	21,909
Truck Loading Rate		0.85			0.85			0.85	
Adjusted Disposal Rate (In ton)	14,510	6,140	20,650	14,560	6,230	20,790	12,540	6,080	18,620

Note: * Excluding Mapo Gu